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Table of Contents

Acronyms and Abbreviations ... vii

1. Introduction ... 1
   - 1.1 GMA 12 ... 1
   - 1.2 Joint Groundwater Planning Process ... 5
   - 1.3 GMA 12 Joint Planning ... 9
2. GMA 12 Desired Future Conditions ... 13
   - 2.1 Sparta, Queen City, Carrizo, Calvert Bluff, Simsboro, and Hooper Aquifers ... 13
   - 2.2 Yegua-Jackson Aquifer ... 14
   - 2.3 Brazos Alluvium Aquifer ... 14
   - 2.4 Non-Relevant Areas of Aquifers ... 15
3. Policy Justification ... 16
4. Technical Justification ... 17
   - 4.1 Central Queen City-Sparta Groundwater Availability Model ... 17
   - 4.2 Potential Pumping Scenarios Using Queen City-Sparta GAM ... 18
   - 4.3 Yegua-Jackson GAM ... 20
   - 4.4 Potential Pumping Scenario Using Yegua-Jackson GAM ... 23
   - 4.5 Brazos River Alluvium GAM ... 24
   - 4.6 Potential Pumping of Brazos River Alluvium ... 27
   - 4.7 Use of Groundwater Availability Models ... 29
5. Factors Considered for the Desired Future Conditions ... 29
   - 5.1 Aquifer Uses and Conditions ... 30
     - 5.1.1 Carrizo-Wilcox Aquifer ... 33
     - 5.1.2 Queen City Aquifer ... 39
     - 5.1.3 Sparta Aquifer ... 42
     - 5.1.4 Yegua-Jackson Aquifer ... 44
     - 5.1.5 Brazos River Alluvium Aquifer ... 44
     - 5.1.6 Trinity Aquifer ... 47
   - 5.2 Water Supply Needs and Water Management Strategies ... 47
   - 5.3 Hydrological Conditions ... 50
     - 5.3.1 Geology and Hydrogeology ... 51
     - 5.3.2 Total Estimated Recoverable Storage (TERS) ... 54
     - 5.3.3 Average Annual Recharge, Inflows, and Discharge ... 56

DRAFT

5.4 Environmental Factors 57
5.5 Subsidence 58
5.6 Socioeconomics 60
5.6.1 Regional Planning Assessment of Socioeconomic Impact 60
5.6.2 Other Considerations of Socioeconomic Impacts 61
5.6.3 Socioeconomic Considerations in GMA-12 63
5.6.4 Impacts of Major and Minor Aquifer DFCs on Socioeconomic Impacts Reasonably Expected to Occur 64
5.7 Private Property Rights 65
5.8 Feasibility of Achieving the Proposed Desired Future Conditions 67
5.9 Any Other Relevant Information 68

6. Other Desired Future Conditions Considered 68
6.1 Proposed Desired Future Conditions 68
6.2 Adopted Desired Future Conditions 71

7. Recommendations and Comments Received 72
7.1 Comments Received by Brazos Valley GCD 73
7.2 Comments Received by Fayette County GCD 73
7.3 Comments Received by Lost Pines GCD 73
7.4 Comments Received by Mid-East Texas GCD 73
7.5 Comments Received by Post Oak Savannah GCD 73
7.6 Comments Received from Texas Water Development Board 73

8. Summary 74
8.1 Summary of DFCs 74
8.2 Rationale and Justification for DFC Selection 75

9. References 76

DRAFT

List of Figures

1-1 Groundwater Management Areas in Texas 2
1-2 Groundwater Conservation Districts in GMA 12 3
1-3 Major Aquifers in GMA 12 4
1-4 Minor Aquifers in GMA 12 6
4-1 Conceptual Flow Model of the Sparta, Queen City, and Carrizo-Wilcox Aquifers (from Young and others, 2018, Figure 3.5a) 19
4-2 Yegua-Jackson Aquifer System and Location (from Deeds and others, 2010, Figure .2.4) 21
4-3 Conceptual Flow Model of the Yegua-Jackson Aquifer (from Deeds and others, 2010, Figure 5.0.1) 22
4-4 Extent of the Brazos River Alluvium Aquifer Groundwater Availability Model (from Ewing and Jigmond, 2016, Figure 1.0.3) 25
4-5 Conceptual Groundwater Flow Model (Cross-Sectional View) for the Brazos River Alluvium Aquifer (from Ewing and Jigmond, 2016, Figure 2.0.1) 26
5-1 Surface Geology of GMA 12 31
5-2 Extent of Carrizo-Wilcox Aquifer within GMA 12 34
5-3 Extent of Carrizo Aquifer within GMA 12 36
5-4 Extent of Calvert Bluff Aquifer within GMA 12 37
5-5 Extent of Simsboro Aquifer within GMA 12 38
5-6 Extent of Hooper Aquifer within GMA 12 40
5-7 Extent of Queen City Aquifer within GMA 12 41
5-8 Extent of Sparta Aquifer within GMA 12 43
5-9 Extent of Yegua-Jackson Aquifer within GMA 12 45
5-10 Extent of Brazos River Alluvium Aquifer within GMA 12 46
5-11 Generic Cross-Section of the Carrizo-Wilcox Aquifer in GMA 12 (modified from Ashworth and Hopkins, 1995) 51
5-12 Socioeconomic Impacts Analysis – 2011 Brazos G Regional Water Plan Lost Income by Sector (millions of $) 62
5-13 Social Impacts of Water Shortages in Region G 63

DRAFT

List of Tables

1-1 A Simplified Stratigraphic Column for GMA 12 7
1-2 Population Projection from the 2017 State Water Plan 7
1-3 GMA 12 Meeting Convened from 2018 to 2021 10
1-4.Public Hearings Conducted by the GCDs Regarding the Proposed DFCs 13
2-1 Adopted DFCs for the Sparta, Queen City, Carrizo, Calvert Bluff, Simsboro, and Hooper Aquifers 14
2-2 Adopted DFCs for the Yegua and Jackson Aquifers 15
2-3 Adopted DFCs for the Brazos River Alluvium Aquifer 15
4-1 Average Aquifer Drawdown calculated for Sparta, Queen City, Carrizo, Calvert Bluff, Simsboro, and Hooper Aquifers using S-19 20
4-2 Average Aquifer Drawdown Calculated for Yegua-Jackson Aquifer using YGJK-PS2 24
4-3 Simulated Changes in the Surface Water-Groundwater Exchange in GAM 12 between the BRAA and the Brazos River in 2013 and 2070 28
5-1 Estimated Historical Overall Water Use Met with Groundwater 32
5-2 2018 Metered/Reported Groundwater Production (in acre-feet) 32
5-3 Total Estimated Groundwater Production from the Carrizo-Wilcox Aquifer in 2019 (in acre-feet) 33
5-4 Total Estimated Groundwater Production from the Queen City Aquifer in 2019 (in acre-feet) 39
5-5 Total Estimated Groundwater Production from the Sparta Aquifer in 2019 (in acre-feet) 42
5-6 Total Estimated Groundwater Production from the Yegua-Jackson Aquifer in 2019 (in acre-feet) 44
5-7 Total Estimated Groundwater Production from the Brazos River Alluvium Aquifer in 2019 (in acre-feet) 47
5-8 Regional Water Plan Amounts for Supplies, Demands, and Strategies in 2070 for GMA 12 GCDs (in acre-feet) 49
5-9 Existing Operating Permits for Groundwater Production in GMA 12 50
5-10 Total Estimated Recoverable Storage (TERS) in the Carrizo-Wilcox Aquifer in Fayette County 55
5-11 Total Amount of Groundwater in Storage (TERS) (in acre-feet) in GMA 12 56
6-1 Proposed DFCs for GMA 12 for the Sparta, Queen City, Carrizo, Calvert Bluff, Simsboro, and Hooper Aquifers 69

DRAFT

6-2 Proposed DFCs for GMA 12 for the Yegua-Jackson Aquifer....69
6-3 Proposed DFCs for GMA 12 for the Brazos River Alluvium....70
6-4 Drawdowns from 2011 to 2070 Considered for Reduced Simsboro Pumpage in Lost Pines GCD in GAM Run S-20....72
8-1 Final Adopted DFCs for the Sparta, Queen City, Carrizo, Calvert Bluff, Simsboro, and Hooper Aquifers....74
8-2 Adopted DFCs for the Yegua-Jackson Aquifer....75
8-3 Adopted DFCs for the Brazos River Alluvium Aquifer.....75

List of Appendices

A AGENDAS FOR GMA 12 JOINT GROUNDWATER PLANNING MEETINGS FROM 2018 TO 2021
B MINUTES FOR GMA 12 JOINT GROUNDWATER PLANNING MEETINGS FROM 2018 TO 2021
C GMA-12 RESOLUTION FOR PROPOSED DFCS DATED APRIL 22, 2021
D NOTICES AND MINUTES OF GCD PUBLIC HEARINGS ON PROPOSED GMA 12 DFCS
E NOVEMBER 12, 2021 PRESENTATION "GMA 12: S-12, S-19, AND S-20 MODEL RESULTS"
F TERS FOR GMA 12 (GAM TASK 13-035_v2)
G GAM RUN 18-021 FOR BRAZOS VALLEY GCD
H GAM RUN 17-019 FOR FAYETTE COUNTY GCD
I GAM RUN 16-014 FOR LOST PINES GCD
J GAM RUN 18-020 FOR MID-EAST TEXAS GCD
K GAM RUN 16-015 FOR POST OAK SAVANNAH GCD
L JULY 24, 2020 PRESENTATION "AQUIFER USES AND CONDITIONS CONSIDERATION DISCUSSION"
M JULY 24, 2020 PRESENTATION "GMA-12: NEEDS AND STRATEGIES"
N JANUARY 29, 2020 PRESENTATION "HYDROLOGICAL CONDITIONS CONSIDERATION DISCUSSION"
O SEPTEMBER 18, 2020 PRESENTATION "PRESENTATION TO GMA-12: CONSIDERATION FOR ENVIRONMENTAL IMPACTS"

P JULY 24, 2020 PRESENTATION "EVALUATION OF THE POTENTIAL IMPACT OF SUBSIDENCE IN GMA12"

Q OCTOBER 22, 2020 PRESENTATION "GMA12 SOCIOECONOMIC IMPACTS CONSIDERATIONS"

R SEPTEMBER 18, 2020 PRESENTATION "GROUNDWATER MANAGEMENT AREA 12: CONSIDERATION OF THE IMPACT ON THE INTERESTS AND RIGHTS IN PRIVATE PROPERTY IN THE ADOPTION OF DESIRED FUTURE CONDITIONS OF AQUIFERS"

S POST OAK SAVANNAH GCD POSITION PAPER ON GMA 12 PROPOSED DFCS FOR THE 3RD JOINT PLANNING CYCLE

T BRAZOS VALLEY GCD WRITTEN RESPONSE TO POST OAK SAVANNAH GCD POSITION PAPER ON PROPOSED DFCS

U GMA 12'S RESPONSES TO COMMENTS FOR BRAZOS VALLEY GCD

V GMA 12'S RESPONSES TO COMMENTS FOR FAYETTE COUNTY GCD

W GMA 12'S RESPONSES TO COMMENTS FOR LOST PINES GCD

X GMA 12'S RESPONSES TO COMMENTS FOR POST OAK SAVANNAH GCD

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Acronyms and Abbreviations

ac-ft/yr	acre-feet per year
DBS&A	Daniel B. Stephens & Associates
DFCs	desired future conditions
GAM	groundwater availability model
GCD	Groundwater Conservation District
GMA	Groundwater Management Area
gpm	gallons per minute
HB	House Bill
INTERA	INTERA Incorporated
IO models	input/output models
MAG	modeled available groundwater
mg/L	milligrams per liter
PS	potential scenarios
RWPG	regional water planning group
SAM	social accounting matrix
TDS	total dissolved solids
TERS	total estimated recoverable storage
TWDB	Texas Water Development Board
WSC	Water Supply Corporation

1. Introduction

1.1 GMA 12

Groundwater management areas (GMAs) were created "in order to provide for the conservation, preservation, protection, recharging, and prevention of waste of the groundwater, and of groundwater reservoirs or their subdivisions, and to control subsidence caused by withdrawal of water from those groundwater reservoirs or their subdivisions, consistent with the objectives of Section 59, Article XVI, Texas Constitution . . ." (Texas Water Code §35.001). The responsibility for GMA delineation was delegated to the Texas Water Development Board (TWDB) (Section 35.004, Chapter 35, Title 2, Texas Water Code). The initial GMA delineations were adopted on December 15, 2002, and are modified as necessary according to agency rules. There are 16 GMAs in Texas. Figure 1-1 shows the boundaries of these 16 GMAs, including GMA 12.

GMAs consist of all groundwater conservation districts (GCDs) located within the GMA boundary. Figure 1-2 shows the location of the five GCDs that are contained wholly or in part within the boundary of GMA 12: Brazos Valley GCD, Fayette County GCD, Lost Pines GCD, Mid-East Texas GCD, and Post Oak Savannah GCD. The GMA area may also include counties that are not included in a GCD. GMA 12 includes portions of four counties that are not associated with GCDs: Falls, Limestone, Navarro, and Williamson counties.

Portions of three major aquifers, as defined by TWDB, fall within GMA 12: the Gulf Coast Aquifer, the Carrizo-Wilcox Aquifer, and the Trinity Aquifer. Figure 1-3 shows the outlines of the major aquifers within GMA 12. The Carrizo-Wilcox Aquifer is by far the most extensive and important aquifer in the region, occurring in all five GCDs and providing significant quantities of groundwater across the GMA. The other two major aquifers that occur within GMA 12 only occur in a very limited area within the GMA; the Gulf Coast Aquifer only outcrops in a very small area in the southernmost portion of Brazos County, along the southeast boundary of GMA 12, and the Trinity Aquifer subcrop only exists in a small area along the northwest GMA 12 boundary in Bastrop, Lee, and Williamson counties.

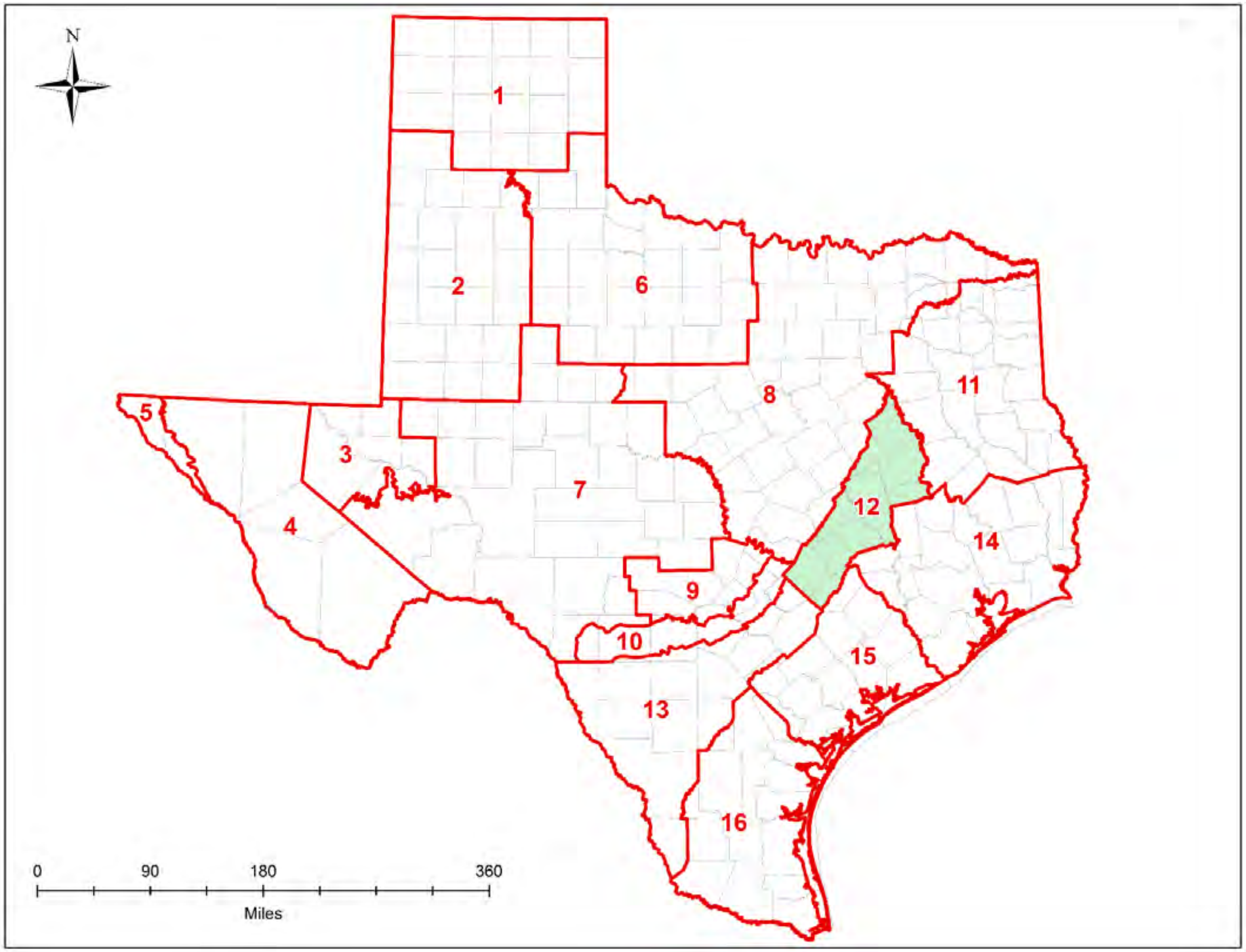

Figure 1-1. Groundwater Management Areas in Texas

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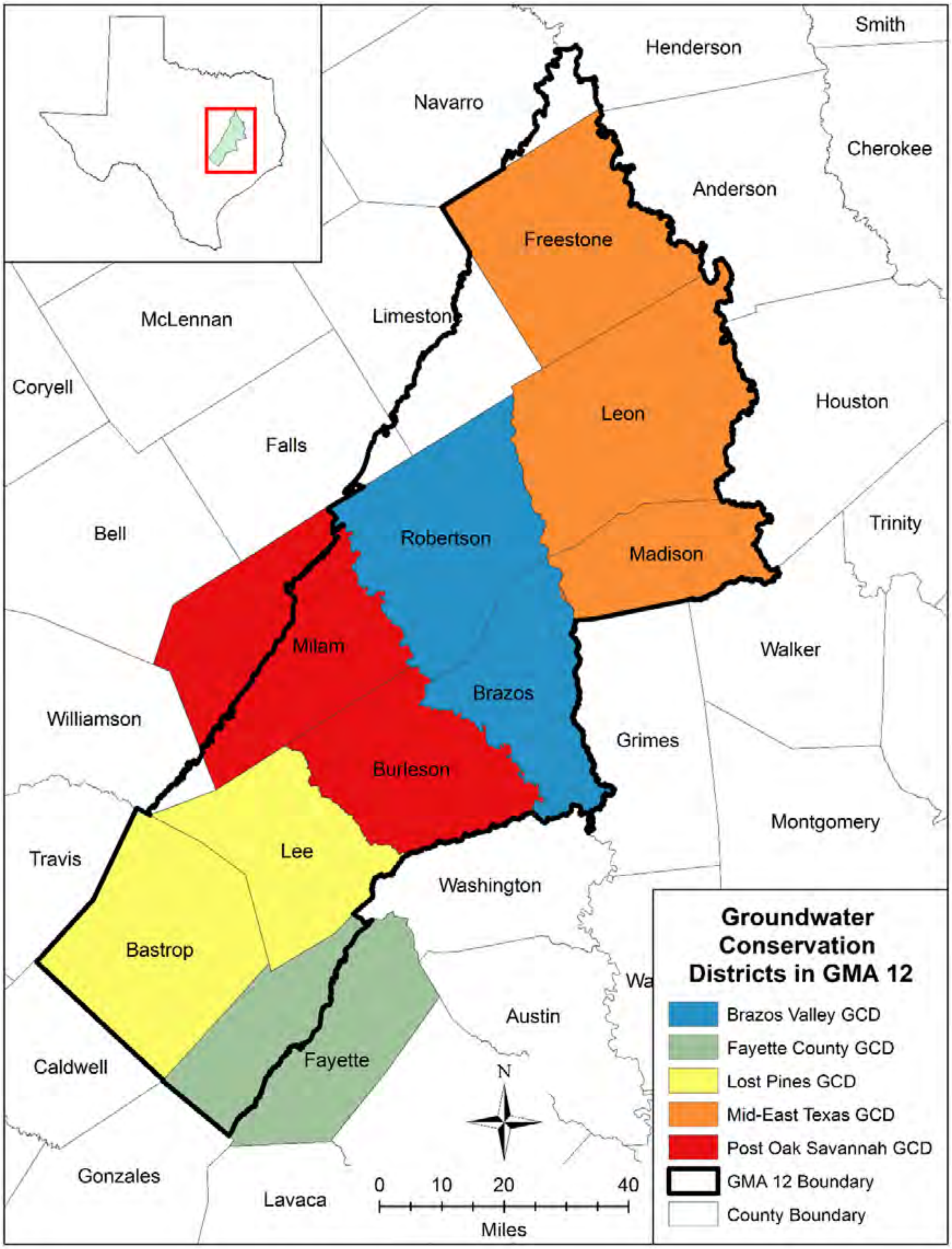

Figure 1-2. Groundwater Conservation Districts in GMA 12

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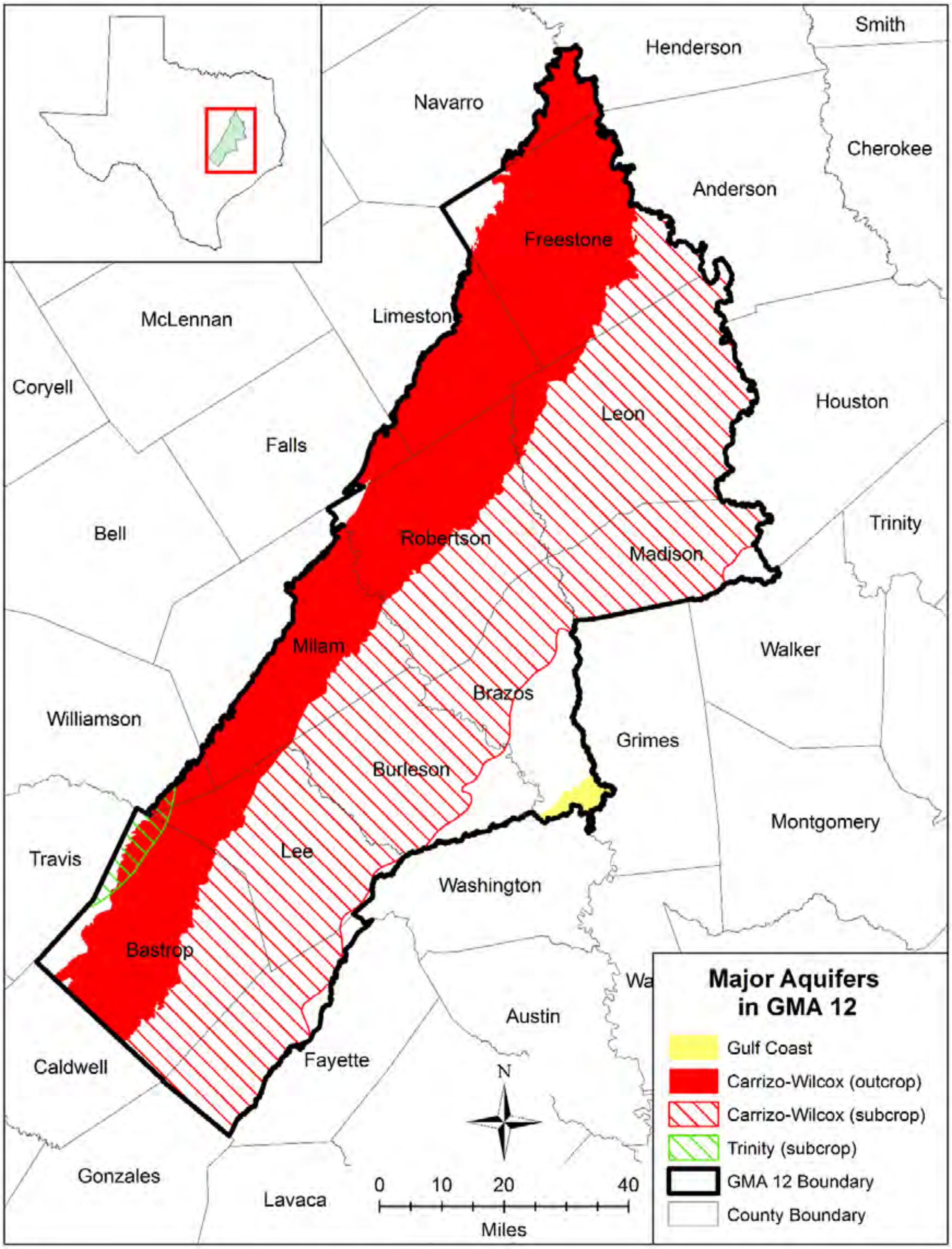

Figure 1-3. Major Aquifers in GMA 12

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In addition to these major aquifers, portions of four minor aquifers, as defined by TWDB, are also present within GMA 12: the Brazos River Alluvium Aquifer, the Queen City Aquifer, the Sparta Aquifer, and the Yegua-Jackson Aquifer. Figure 1-4 shows the outlines of the minor aquifers within GMA 12. All minor aquifers are used as water supply sources within GMA 12. Table 1-1 is a stratigraphic column showing the relative ages of the aquifers.

In this report, the Carrizo-Wilcox Aquifer is subdivided into four major hydrogeologic units, from youngest to oldest: the Carrizo Aquifer, the Calvert Bluff Aquifer (Upper Wilcox Aquifer), the Simsboro Aquifer (Middle Wilcox Aquifer), and the Hooper Aquifer (Lower Wilcox Aquifer), as shown in Table 1-1.

GMA 12 includes all or part of 14 Texas counties: Bastrop, Brazos, Burleson, Falls, Fayette, Freestone, Lee, Leon, Limestone, Madison, Milam, Navarro, Robertson, and Williamson counties. Table 1-2 lists the 14 counties and their area and population projections. As of the 2020 Census, these counties had a population of about 1,181,495, which is projected to grow to almost 3 million by 2070. Most of this growth will occur in Williamson County, of which only a small portion falls within the GMA 12 boundary. However, even excluding Williamson County, the population of GMA 12 is expected to more than double by 2070, and this growing population and the accompanying water demand could have significant implications for groundwater resources GMA 12. After Williamson County, the most populated and fastest growing counties are Bastrop County, whose population values include fast-growing suburbs of Austin, and Brazos County, which contains the fast-growing Bryan/College Station area.

1.2 Joint Groundwater Planning Process

The joint groundwater planning process was first adopted by the Texas Legislature with the passage of House Bill (HB) 1763 in 2005. One of the requirements of HB 1763 is that, where two or more GCDs are located within the same boundaries of a GMA, the GCDs shall establish desired future conditions (DFCs) for all relevant aquifers in the GMA by no later than September 1, 2010 and every five years thereafter. The deadline for proposing DFCs for adoption for the third round of joint groundwater planning was May 1, 2021. The deadline for approving final DFCs for the third round of joint groundwater planning was January 5, 2022.

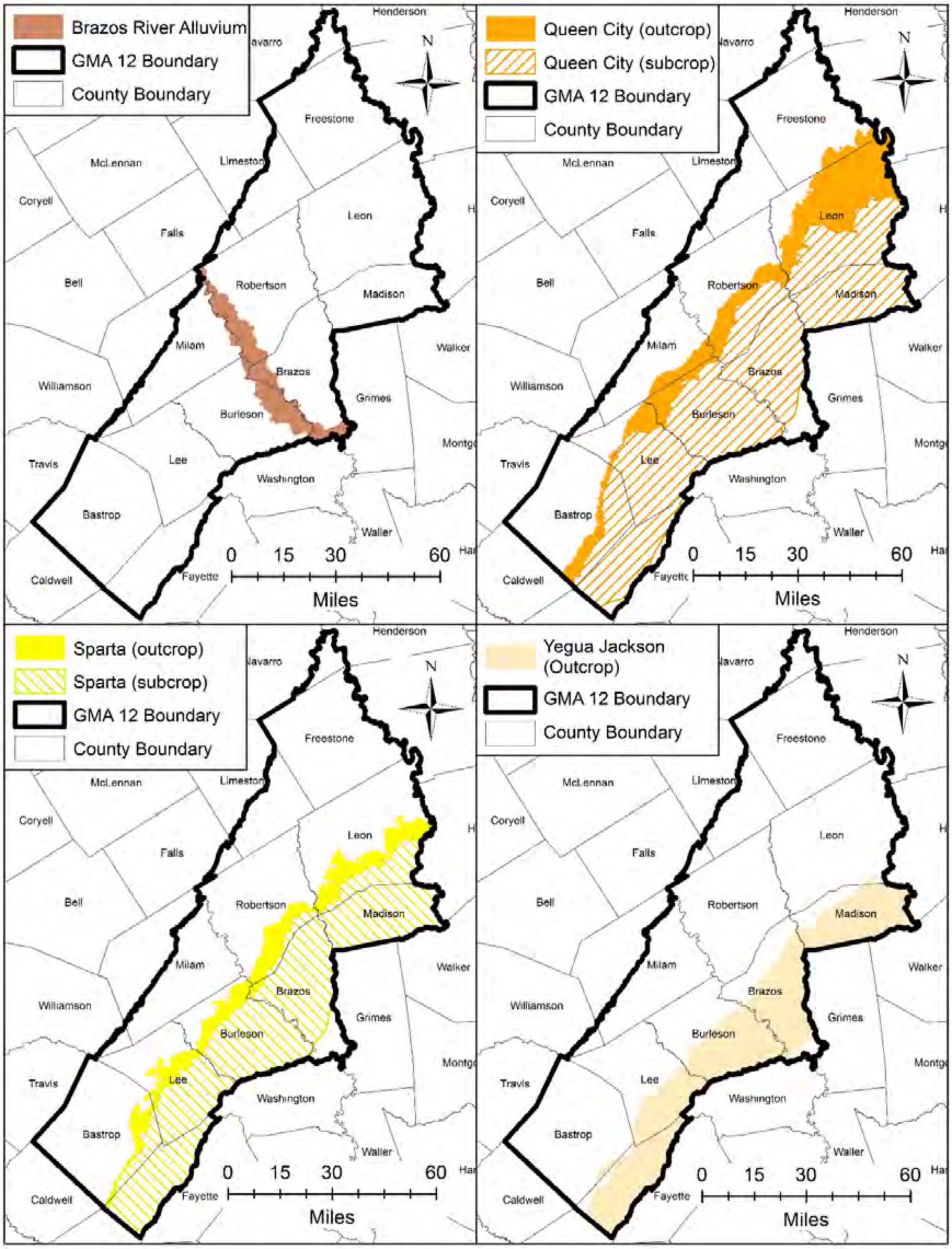

Figure 1-4. Minor Aquifers in GMA 12

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Table 1-1. A Simplified Stratigraphic Column for GMA 12

<table>
<tr><th>System</th><th>Series</th><th>Geologic Unit</th><th>Hydrogeologic Unit</th></tr>
<tr><td>Quaternary</td><td></td><td>Brazos River Alluvium</td><td>Brazos River Alluvium Aquifer</td></tr>
<tr><td rowspan="11">Tertiary</td><td>Upper Eocene</td><td>Jackson Group</td><td rowspan="2">Yegua-Jackson Aquifer</td></tr>
<tr><td rowspan="7">Middle Eocene</td><td>Yegua Formation</td></tr>
<tr><td>Cook Mountain Formation</td><td>confining unit</td></tr>
<tr><td>Sparta Sand</td><td>Sparta Aquifer</td></tr>
<tr><td>Weches Formation</td><td>confining unit</td></tr>
<tr><td>Queen City Sand</td><td>Queen City Aquifer</td></tr>
<tr><td>Reklaw Formation</td><td>confining unit</td></tr>
<tr><td>Carrizo Sand</td><td rowspan="4">Carrizo- Wilcox Aquifer</td></tr>
<tr><td rowspan="2">Lower Eocene</td><td>Calvert Bluff Fm. (Upper Wilcox)</td></tr>
<tr><td>Simsboro Fm. (Middle Wilcox)</td></tr>
<tr><td>Upper Paleocene</td><td>Hooper Fm. (Lower Wilcox)</td></tr>
</table>

Table 1-2. Population Projection from the 2017 State Water Plan

Name	Area [1] (square miles)	Population 2020 [2]	Population 2030	Population 2040	Population 2050	Population 2060	Population 2070
Bastrop	896	97,216	125,559	164,648	217,608	289,140	384,244
Brazos	590	233,849	264,665	302,997	349,894	400,135	455,529
Burleson	678	17,642	19,946	20,838	21,735	22,442	23,022
Falls	774	16,968	20,397	20,610	20,126	20,736	21,364
Fayette	959	24,435	32,384	35,108	37,351	39,119	40,476
Freestone	892	19,435	21,077	22,947	31,142	44,475	73,287
Lee	634	17,478	21,511	22,877	23,375	23,709	23,889
Leon	1,081	15,719	19,536	20,603	22,071	23,340	24,582
Limestone	933	22,146	26,615	27,817	29,134	30,206	31,152
Madison	472	13,455	15,817	16,786	17,872	18,886	19,877
Milam	1,022	24,754	27,793	28,896	30,300	31,501	32,629
Navarro	1,086	52,624	57,032	61,667	71,452	86,952	107,814
Robertson	865	16,757	20,150	21,801	23,525	25,174	26,771
Williamson	1,137	609,017	794,478	987,495	1,195,374	1,431,101	1,675,901
TOTAL		***1,216,703***	***1,181,495***	***1,755,090***	***2,090,959***	***2,486,916***	***2,940,537***

[1] Calculated from the Stratmap county shapefile from TNRIS; [2] from the 2020 Census

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DFCs are defined in Title 31, Part 10, §356.10 (6) of the Texas Administrative Code as "the desired, quantified condition of groundwater resources (such as water levels, spring flows, or volumes) within a management area at one or more specified future times as defined by participating groundwater conservation districts within a groundwater management area as part of the joint planning process." Once DFCs are adopted, the Executive Administrator of the TWDB calculates the modeled available groundwater (MAG) for the aquifers, which is the estimated amount of pumping that will achieve the DFC, and these values are used in regional water planning.

If a GMA includes more than one GCD, the GCDs must engage in a joint groundwater planning process, including at least an annual meeting. Among the requirements for the joint planning process is to adopt DFCs for the management area and, in doing so, consider the following nine factors identified in TWC § 36.108 (d):

1. Aquifer uses or conditions within the management area, including conditions that differ substantially from one geographic are to another
2. The water supply needs and water management strategies included in the state water plan
3. Hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the executive administrator, and the average annual recharge, inflows, and discharge
4. Other environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water
5. The impact on subsidence
6. Socioeconomic impacts reasonably expected to occur
7. The impact on the interests and rights in private property, including ownership and the rights of management area landowners and their lessees
8. The feasibility of achieving the DFC
9. Any other information relevant to the specific DFCs

After the DFCs are adopted by a GMA, the TWDB determines MAGs based on the adopted DFCs. A MAG is defined in Title 31, Part 10, §356.10 (13) of the Texas Administrative Code as "the amount of water that the executive administrator determines may be produced on an average annual basis to achieve a desired future condition."

1.3 GMA 12 Joint Planning

The joint groundwater planning process established by HB 1763 in 2005 and amended by Senate Bill 660 in 2011 is a public, transparent process, where all planning decisions are made in open, publicly noticed meetings in accordance with provisions contained in Texas Water Code Chapter 36. From 2018 to 2021, GMA 12 convened 21 times at the dates listed in Table 1-3. All of the meetings were open to the public and were held at the Post Oak Savannah GCD office in Milano, Texas or, during the COVID-19 pandemic of 2020 to 2021, were held virtually. All meeting notices were posted at least 10 days in advance of the meeting and included an invitation to submit comments, questions, and requests for additional information to the Post Oak Savannah GCD.

Table 1-3 lists the dates and the major discussion topics of the GMA 12 joint planning meetings from 2018 to 2021. Appendix A provides the agenda for all of the GMA 12 meetings. Appendix B provides the minutes for all of the GMA 12 meetings. The GCDs that are members of GMA 12 retain hydrogeologic consultants for GCD-level management and modeling. INTERA Incorporated (INTERA) serves as the consultant for Post Oak Savannah GCD and Mid-East Texas GCD, Daniel B. Stephens & Associates, Inc. (DBS&A) serves as the consultant for Lost Pines GCD and Fayette County GCD, and Groundwater Consultants, LLC (GWC) serves as the consultant for Brazos Valley GCD.

During the GMA 12 meeting on April 20, 2021, GMA 12 proposed the DFCs for adoption. As required by Texas Water Code Section 36.108 (d-2), the proposed DFCs were subsequently mailed to the individual GCDs in GMA 12. A copy of the resolution for proposed DFCs is included as Appendix C. A period of not less than 90 days was provided by each GCD to allow for public comments on the proposed DFCs. During this comment period, each GCD held a public hearing on the proposed DFCs. Table 1-4 lists the dates on which each GCD conducted a public hearing on the proposed DFCs. Minutes for these public hearings are included in Appendix D.

Table 1-3. GMA 12 Meeting Convened from 2018 to 2021

Meeting Date	Quorum Present	Major Discussion Topics
May 11, 2018	Yes	Presentation on the update on Central Carrizo-Wilcox/Queen City-Sparta GAM; Presentation and discussion of MAG peaking factors for BVGCD; Presentations and discussion on monitoring and management strategies protecting DFCs
October 9, 2018	Yes	Presentation on the update on Central Carrizo-Wilcox/Queen City-Sparta GAM; Presentation and discussion of comparison of old vs. new GAM results with PS-12 pumpage; Presentation and discussion of MAG peaking factors for METGCD
January 29, 2019	Yes	Presentation and discussion on a summary of the impacts of the updated GAM and path forward for GMA 12; Presentation and discussion of the possible use of DFC monitoring zones by LPGCD; Discussion on pumping files to be used to evaluate DFC compliance and protective drawdown limits (PDLs); Presentation and discussion of POSGCD DFCs and PDLs; Discussion of Explanatory Report organization; Presentation and discussion on Brazos River Alluvium and GW-SW interactions
May 30, 2019	Yes	Presentation and discussion on monitoring conducted by POSGCD; Presentation on the pumpage in BVGCD from the Brazos River Alluvium; Presentation and discussion on estimated future pumpage in FCGCD and LPGCD; Presentation and discussion on the review Brazos River Alluvium DFCs and MAGs; Presentation and discussion on POSGCD pumpage and permits; Discussion of six future pumping scenarios proposed by GMA 12
August 2, 2019	Yes	Presentation and discussion on a review preliminary GAM run results (S-1 to S-6); Presentation and discussion on an LCRA groundwater-surface water study; Comments from Environmental Stewardship on proposed DFCs
September 24, 2019	Yes	Presentation and discussion on results of S-7 and S-8 pumping scenarios; Presentation and discussion on development of Brazos River Alluvium DFCs; Declaration of Gulf Coast Aquifer as non-relevant; Presentation and discussion on Yegua-Jackson GAM and DFCs; Discussion of future pumping scenarios; Summary by environmental Stewardship on proposed DFCs in GMA 12
November 15, 2019	Yes	Presentation and discussion on results of S-9 pumping scenario; Presentation and discussion on Yegua-Jackson GAM and DFCs; Presentation and discussion on Brazos River Alluvium GAM; Review and discussion of draft white paper on efforts of GMA 12 to use best available science; Discussion of compatibility of DFCs

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Table 1-3 (cont.)

Meeting Date	Quorum Present	Major Discussion Topics
January 29, 2020	Yes	Presentation and discussion on Hydrologic Conditions factor; Presentation and discussion on sensitivity analysis of Carrizo-Wilcox GAM and results of Yegua-Jackson pumping scenario; Finalization of a white paper on the State of GMA 12
July 24, 2020	Yes	VIRTUAL MEETING- Presentation and discussion on Aquifer Uses and Conditions factor; Presentation and discussion on Water Supply Needs and Water Management Strategies factor; Presentation and discussion on Subsidence factor; Presentation and discussion on proposed GAM modification
September 18, 2020	Yes	VIRTUAL MEETING- Discuss update of Central Carrizo-Wilcox/Queen City-Sparta GAM; Presentation and discussion on LCRA-RW Harden GW-SW study; Presentation and discussion on environmental Impacts factor; Presentation and discussion on Private Property Rights factor; Presentation and discussion on Vista Ridge pumping and water levels;
October 22, 2020	Yes	VIRTUAL MEETING- Presentation and discussion on an update of impacts of Vista Ridge project; Discussion on the update on progress of Central Carrizo-Wilcox/Queen City-Sparta GAM with TWDB; Presentation and discussion on Socioeconomic impacts factor; Presentation and discussion on results of future pumping scenarios S-7 with updated model
December 10, 2020	Yes	VIRTUAL MEETING- Discussion on progress of Central Carrizo-Wilcox/Queen City-Sparta GAM update with TWDB; Presentation and discussion by Environmental Stewardship on surface water-groundwater interactions; Presentation and discussion on GMA 12 schedule; Discussion on comments received by GMA 12 stakeholders
January 15, 2021	Yes	VIRTUAL MEETING- Discussion of DFCs and variances; Presentation and discussion on GAM run results, including results of S-10; Presentation and discussion on Yegua-Jackson GAM run results; Discussion and approval of proposed DFCs for the Yegua-Jackson Aquifer; Discussion on non-relevant aquifers in GMA 12
February 12, 2021	Yes	VIRTUAL MEETING- Presentation by SAWDF on "GMA 12 DFC Considerations"; Presentation and discussion on GAM run results, including results of S-11; Discussion of variances; Presentation and discussion on proposed DFCs for the Brazos River Alluvium; Declaration of LPGCD non-relevant aquifers in GMA 12; Presentation by TWDB on BRACS data collection in the Upper Coastal Plains; Presentation and discussion on GMA 12 DFCs and Carrizo pumpage in POSGCD

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Table 1-3 (cont.)

Meeting Date	Quorum Present	Major Discussion Topics
March 18, 2021	Yes	VIRTUAL MEETING- Presentation and discussion on GAM run results, including results of S-12 and S-13; Consider proposed DFCs for all aquifers in GMA 12; Approve DFCs for Brazos River Alluvium and Yegua-Jackson Aquifers; Discussion of expressions of DFCs and variances; Declaration of Wilcox aquifers in FCGCD as non-relevant
April 20, 2021	Yes	VIRTUAL MEETING- Presentation and discussion on GW-SW interaction with respect to Run S-13; Presentation by Environmental Stewardship discussing current and proposed DFCs and DFCs to protect groundwater discharges to streams; Discuss and reconsider proposed DFCs for all aquifers in GMA 12; Discuss past and future pumping scenarios for the Carrizo-Wilcox
June 24, 2021	Yes	Presentation and discussion on POSGCD concerns on DFC planning; Discussion of requirements of Chapter 36 for adopting DFCs
October 6, 2021	Yes	Presentation and discussion on a proposed GAM update by POSGCD; Presentation on POSGCD permitting and rules; Presentation on POSGCD approach for developing DFCs
October 13, 2021	Yes	Presentation and discussion on results of GAM Run S-15; Discussion on DFCs for all aquifers in GMA 12
November 12, 2021	Yes	Presentation and discussion on results of GAM Runs S-19 and S-20; Preliminary adoption of DFCs for Sparta, Queen City, Carrizo, Calvert Bluff, Simsboro, and Hooper Aquifers using results of Run S-19
November 30, 2021	Yes	Final adoption of GMA 12 DFCs (with drawdowns from GAM Run S-19)

Table 1-4. Public Hearings Conducted by the GCDs Regarding the Proposed DFCs

GCD	Public Hearing Date
Brazos Valley GCD	June 10, 2021
Fayette County GCD	July 12, 2021
Lost Pines GCD	August 18, 2021
Mid-East Texas GCD	June 22, 2021
Post Oak Savannah GCD	July 13, 2021

2. GMA 12 Desired Future Conditions

2.1 Sparta, Queen City, Carrizo, Calvert Bluff, Simsboro, and Hooper Aquifers

The Sparta, Queen City, and Carrizo aquifers are present and used in all GCDs within GMA 12. Therefore, all GCDs submitted DFCs for these aquifers. The Calvert Bluff, Simsboro, and Hooper aquifers are present in all GCDs but not used in Fayette County. Therefore, GMA 12 declared these aquifers not relevant for Fayette County, and Fayette County GCD did not submit a DFC for these aquifers. For the purpose of establishing and evaluating DFCs, the updated groundwater availability model (GAM) for the Queen City and Sparta Aquifers (INTERA and others, 2020) was used to determine the compatibility and physical possibility of the DFCs proposed by each GCD. Note that this GAM also includes the Carrizo-Wilcox Aquifer. The DFCs proposed by each GCD for these six aquifers are provided in Table 2-1, as well as the DFC adopted by GMA 12 as a whole. The DFC is based on the average drawdown from January 2011 through December 2070, except for Brazos Valley GCD, which uses a DFC based on the average drawdown from January 2000 through December 2070.

Table 2-1. Adopted DFCs for the Sparta, Queen City, Carrizo, Calvert Bluff, Simsboro, and Hooper Aquifers

GCD or County	Average Aquifer Drawdown (feet) measured from January 2011 through December 2070					
	Sparta	Queen City	Carrizo	Calvert Bluff	Simsboro	Hooper
Brazos Valley GCD *	53	44	84	111	262	167
Fayette County GCD **	43	73	140	Declared as non-relevant		
Lost Pines GCD	22	28	134	132	240	138
Mid-East Texas GCD	25	20	48	57	76	69
Post Oak Savannah GCD	32	30	146	156	278	178
Falls County	—	—	—	—	7	3
Limestone County	—	—	—	2	3	3
Navarro County	—	—	—	0	1	0
Williamson County	—	—	—	25	31	24
GMA-12	***33***	***32***	***96***	***98***	***169***	***110***

***** Brazos Valley GCD DFCs are for2000 through December 2070.
** Fayette County GCD DFCs are for all of Fayette County.

2.2 Yegua-Jackson Aquifer

The Yegua-Jackson Aquifer is present in all GCDs in GMA 12. Lost Pines GCD did not propose a DFC because the district has declared the Yegua-Jackson Aquifer as a non-relevant aquifer. The DFCs proposed by each GCD for the Yegua-Jackson Aquifer are provided in Table 2-2, as well as the DFC adopted by GMA 12 as a whole. For the purpose of establishing and evaluating DFCs, the GAM for the Yegua-Jackson Aquifer (Deeds and others, 2010) was used to determine the compatibility and physical possibility of the DFCs submitted by each GCD. The DFC is based on the average drawdown from January 2010 through December 2069.

2.3 Brazos Alluvium Aquifer

In GMA 12, the Brazos River Alluvium Aquifer is only present in Post Oak Savannah GCD and the Brazos Valley GCD. For this reason, GMA 12 adopted DFCs at a county level in these two GCDs, as shown in Table 2-3. DFCs for the Brazos River Alluvium Aquifer were not adopted for the entire GMA 12, as that would not be applicable.

Table 2-2. Adopted DFCs for the Yegua-Jackson Aquifer

GCD	Average Aquifer Drawdown (feet) measured from January 2011 through December 2069
Brazos Valley GCD	67
Fayette County GCD	81
Lost Pines GCD	—
Mid-East Texas GCD	8
Post Oak Savannah GCD	61
GMA-12	***55***

Table 2-3. Adopted DFCs for the Brazos River Alluvium Aquifer

GCD	County	Brazos River Alluvium Aquifer
Brazos Valley	Brazos and Robertson	North of State Highway 21: Percent saturation shall average at least 30% of total well depth from January 2013 to December 2069. South of State Highway 21: Percent saturation shall average at least 40% of total well depth from January 2013 to December 2069.
Post Oak Savannah	Burleson	A decrease in 6 feet in the average saturated thickness over the period from January 2010 to December 2069.
	Milam	A decrease of 5 feet in average saturated thickness over the period from January 2010 to December 2069.

2.4 Non-Relevant Areas of Aquifers

There are four areas where aquifers were declared non-relevant during the current cycle of joint groundwater planning. The Trinity Aquifer was declared non-relevant in Bastrop, Lee, and Williamson counties because of its small areal coverage, great depth, poor water quality, and lack of use. The Yegua-Jackson Aquifer was declared non-relevant in Lost Pines GCD because it has a minimal amount of exempt pumpage within the district. The Wilcox portion of the Carrizo-Wilcox Aquifer was declared non-relevant in Fayette County GCD because of the poor water quality, the great depth to these units, and the lack of use. The Gulf Coast aquifer was declared non-relevant in Brazos Valley GCD because it is thin, can only provide water in small quantities, and is very limited in areal extent.

3. Policy Justification

The adoption of DFCs by GCDs, pursuant to the requirements and procedures set forth in Texas Water Code Chapter 36, is an important policy-making function. DFCs are planning goals that state the desired conditions of the groundwater resources in the future in order to promote better long-term management of those resources. GCDs are authorized to use different approaches in developing and adopting DFCs based on local conditions and the consideration of other statutory criteria as set forth in Texas Water Code Section 36.108.

As part of their evaluation of DFCs, GMA 12 considered the nine factors listed in Texas Water Code Section 36.108(d). In addition to these nine factors, GMA 12 evaluated whether the DFCs provided a balance between the highest practicable level of groundwater production and the conservation, preservation, protection and recharging, and prevention of waste of groundwater in GMA 12. While much of this process was guided by scientific analysis including predictions from groundwater availability models, the actual creation of DFCs requires a blending of both science and policy. Policy is able to consider the limitations and uncertainty inherent in groundwater availability models, and provide guidance for and define the bounds of what these scientific tools can reasonably be expected to accomplish.

In evaluating the DFCs, GMA 12 and the individual districts recognize that (1) the production capability of the aquifers varies significantly across GMA 12, (2) historical groundwater production is significantly different across GMA 12, and (3) the importance of groundwater production to the social-economic livelihood of an area is significantly varied among the districts. As a result of this recognition, a key GMA 12 policy decision was to allow districts to set different DFCs for the portion of an aquifer within their boundaries, as long as the different DFCs could be shown to be physically possible. The allowance of different DFCs among the districts is justified for several reasons. First, the Texas Water Code Section 36.108(d)(1) authorizes the adoption of different DFCs for different geographic areas over the same aquifer based on the boundaries of political subdivisions. The statute expressly and specifically directs GCDs "to consider uses or conditions of an aquifer within the management area, including conditions that differ substantially from one geographic area to another when developing and adopting DFCs for:

1. each aquifer, subdivision of an aquifer, or geologic strata located in whole or in part within the boundaries of the management area, or

2. each geographic area overlying an aquifer in whole or in part or subdivision of an aquifer within the boundaries of the management area."

The legislature's addition of the phrase "in whole or in part" makes it clear that GCDs may establish a "different" DFC for a geographic area that does not cover the entire aquifer but only part of that aquifer. In establishing DFCs, GMA 12 has used county and GCD boundaries to define "geographic areas." By statute, GCDs cannot regulate outside of their district boundary, and the rules that they pass in order to regulate the management of groundwater only apply within their boundaries. Therefore, GMA 12 recognized that in order to facilitate responsible management of groundwater resources, GMAs should develop separate DFCs for each GCD within the GMA.

Each GMA 12 GCD compiled all relevant comments received during the 90-day public comment period regarding the proposed DFCs and suggested revisions to the proposed DFCs and the basis for the revisions. The comments received and the GMA's responses to them are summarized in Section 7 and provided in Appendices S through W.

Based on public comments, District Representatives of GMA 12 considered and approved limited changes to the proposed DFCs. The DFCs that GMA 12 considered and proposed for final adoption, inclusive of all non-substantive changes, provided acceptable drawdown levels in the various aquifers on a county-by county basis and across the entire GMA 12 area.

4. Technical Justification

4.1 Central Queen City-Sparta Groundwater Availability Model

The proposed DFCs for the Sparta, Queen City, Calvert, Simsboro, and Hooper aquifers were developed based on simulations of future pumping scenarios using the updated GAM for the Central Queen City-Sparta/Carrizo-Wilcox Aquifers (INTERA and others, 2020). Groundwater availability models are integrated tool for the assessment of water management strategies to directly benefit state planners, regional water planning groups and groundwater conservation districts. The updated GAM supersedes the GAM of the Central Carrizo-Wilcox Aquifer (Dutton and others, 2003) and the GAMs of the Central Queen City-Sparta/Carrizo-Wilcox Aquifers (Young and others, 2018; Kelley and others, 2004). The GAM (INTERA and others, 2020) used in the current cycle of joint groundwater planning was calibrated for the time period from 1930 through the end of 2010, and is a minor update of the GAM developed by Young and others (2018).

As explained by Young and others (2018) the large grid cells that were used to develop the model prevents accurate model predictions at specific locations such as a particular well. The GAM documentation (Young and others, 2018) also states that "the GAM is accurate at a scale of tens of miles, which is adequate to understand groundwater availability at the regional scale."

The current GAM (INTERA and others, 2020) simulates groundwater flow using the ten model layers shown on Figure 4-1, which is a conceptual "block diagram" of groundwater flow paths simulated by the GAM. The model simulates varying degrees of vertical interaction between aquifers, which can result in pumping effects in a particular aquifer spreading to the aquifers above or below. The magnitude of this effect will vary substantially based on the aquifer hydraulic parameters assigned to aquifers in the GAM. As with all models, there are limitations to the current GAM, but it is the best tool available for estimating the effects of pumping the relevant aquifers in GMA 12. Several different potential pumping scenarios were developed and considered by GMA 12 from 2019 to 2021. These pumping scenarios helped GMA 12 to predict the impact that varying amounts of pumping would have on future water levels across the GMA.

4.2 Potential Pumping Scenarios Using Queen City-Sparta GAM

Modeling simulations were performed for the period from 2011 to 2070 using the GAM. Because the GAM calibration/verification ended in 2010, the simulations started where the calibrated model ended and continued through the planning period defined by the TWDB guidelines.

Several future pumping scenarios from 2011 to 2070 were used by the GMA to predict water level change. The first pumping scenario was named PS-1. PS-1 was generated by combining pumping files that were created by each GCDs for their counties and possibly nearby counties not associated with a GCD in GMA 15. Well File PS-1 served as the baseline pumpage for their district, and all subsequent well files were based on the initial version. After the development of the initial predictive pumping file, different pumping scenarios were developed to evaluate the impacts of varying amounts of pumpage in the GMA on water levels in each GCD. Specific predictive pumping scenarios were also developed to evaluate varying amounts of production from the Carrizo Aquifer in POSGCD and from the Simsboro Aquifer in LPGCD, among others.

The impact of pumping outside of the GMA (in GMA 13) was also evaluated. The results of these simulations were presented to the GMA meetings held from 2019 to 2021.

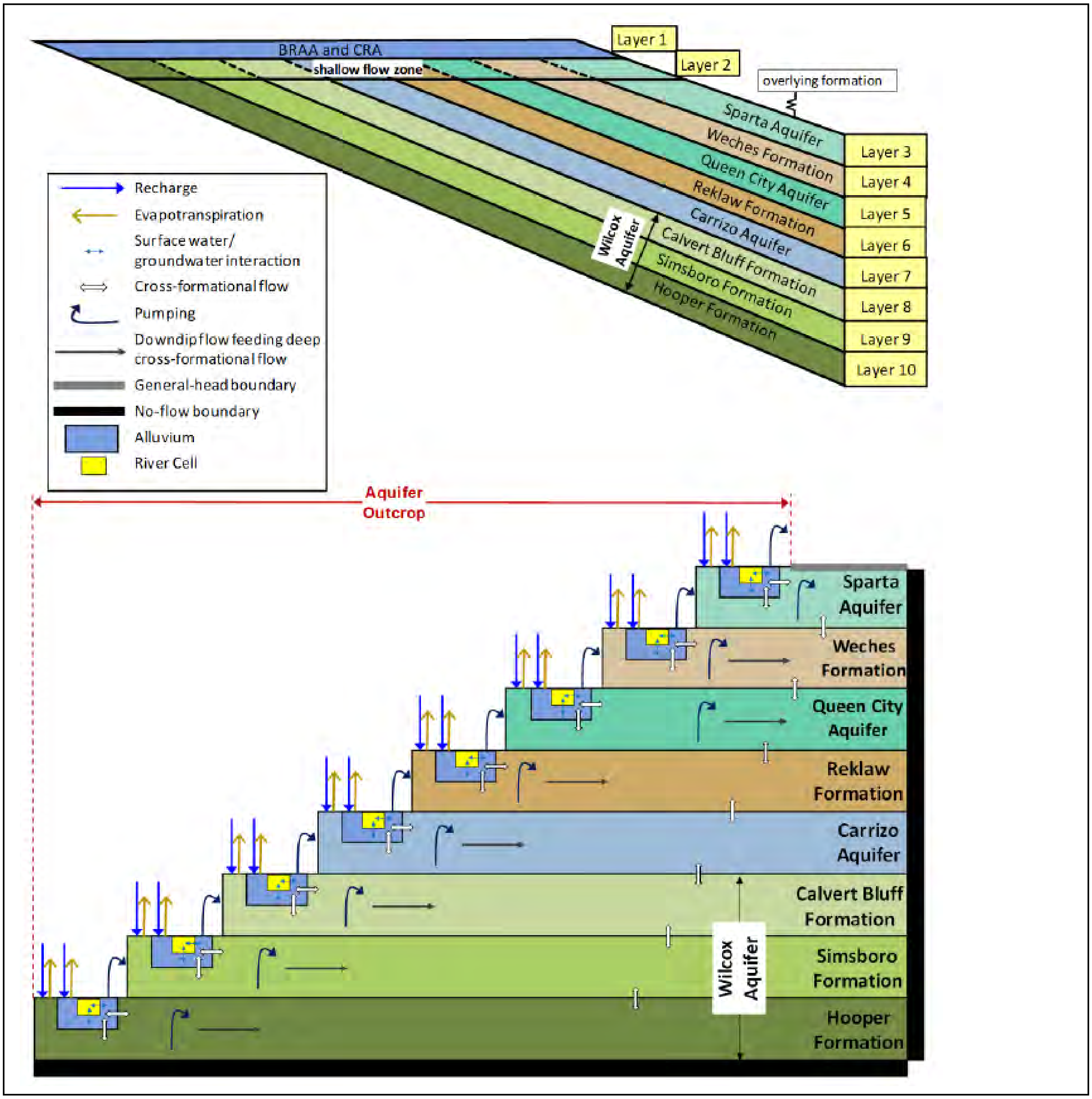

Figure 4-1. Conceptual Flow Model of the Sparta, Queen City, and Carrizo-Wilcox Aquifers (from Young and others, 2018, Figure 3.5a)

All of the simulation results showed substantial changes in the predicted drawdowns within GMA 12 in one or more aquifers in a GCD from the DFCs that were approved in 2017. This occurred for several reasons. First, the amount of pumping that occurred for some aquifers in the GCDs changed significantly from the current MAGs for the aquifers. Second, the updated GAM contains significantly different properties for most of the faults and the aquifers than the GAM used in the 2017 joint planning period. The results of a GAM simulation S-19 were adopted by GAM 12 to support the adopted DFCs was presented to GMA 12 on November 12, 2021. A copy of that presentation is included in Appendix E. Table 4-1 provides the average drawdowns simulated using S-19.

Table 4-1. Average Aquifer Drawdown calculated for Sparta, Queen City, Carrizo, Calvert Bluff, Simsboro, and Hooper Aquifers using S-19

GCD or County	Average Aquifer Drawdown (feet) measured from January 2011 through December 2070					
	Sparta	Queen City	Carrizo	Calvert Bluff	Simsboro	Hooper
Brazos Valley GCD	47	40	72	89	195	136
Fayette County GCD	43	73	140	Declared as non-relevant		
Lost Pines GCD	22	28	134	132	240	138
Mid-East Texas GCD	25	20	48	57	76	69
Post Oak Savannah GCD	32	30	162	156	278	178
Falls County	--	--	--	--	7	3
Limestone County	--	--	--	2	3	3
Navarro County	--	--	--	0	1	0
Williamson County	--	--	--	25	31	24
GMA-12	***33***	***32***	***96***	***98***	***169***	***110***

4.3 Yegua-Jackson GAM

The proposed DFCs for the Yegua-Jackson Aquifer were developed based on simulations of future pumping scenarios using the GAM for the Yegua-Jackson (Deeds and others, 2010). The Yegua-Jackson Aquifer is a minor aquifer in Texas that is primarily used for rural domestic water uses and to a lesser degree for irrigation, public supply, and industrial uses. The hydrogeological framework of the aquifer system and its location in the state are shown in

Figure 4-2. The GAM was developed using MODFLOW 2000 and consists of five layers. The conceptual model representation is shown in Figure 4-3.

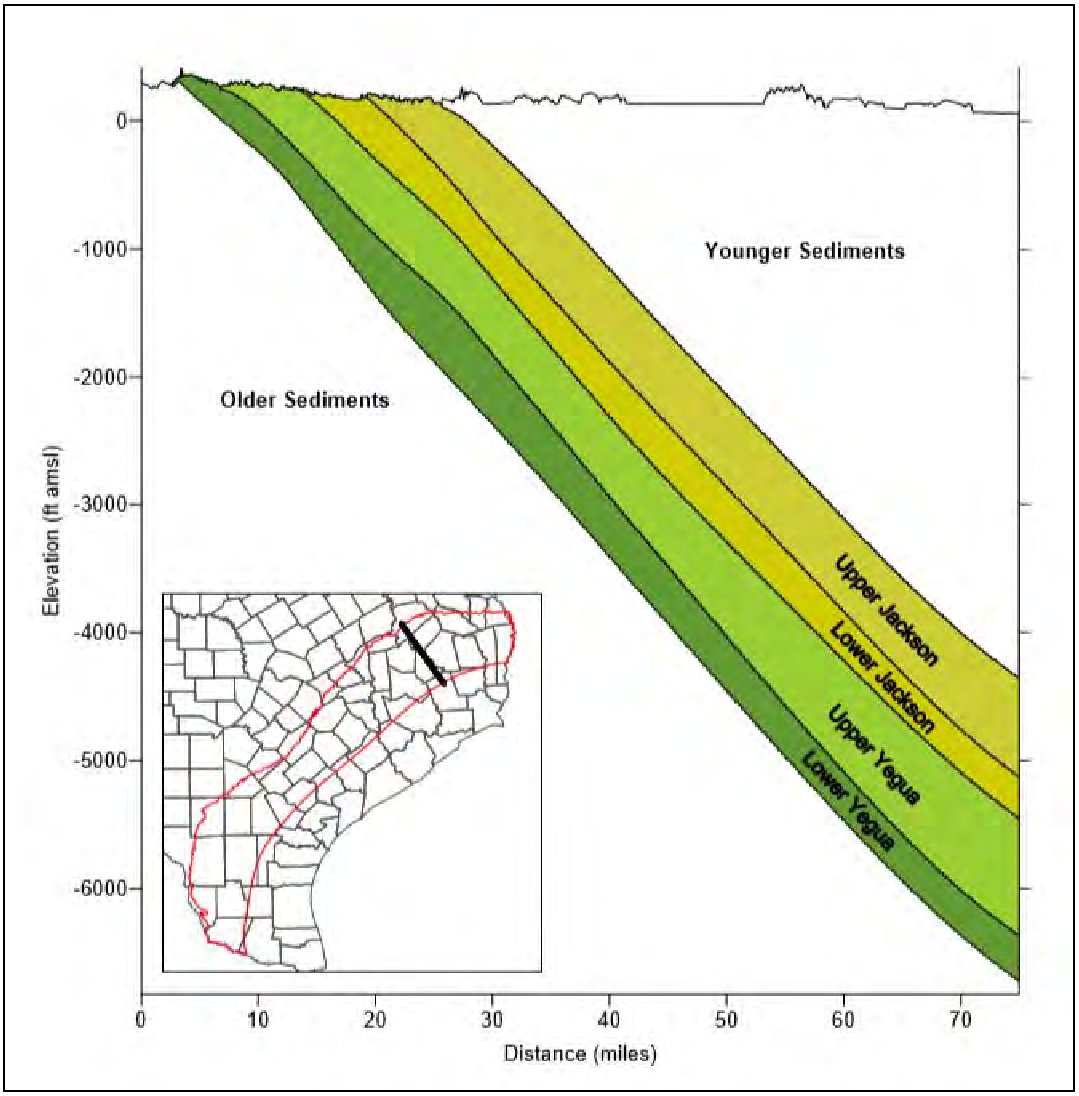

Figure 4-2. Yegua-Jackson Aquifer System and Location (from Deeds and others, 2010, Figure .2.4)

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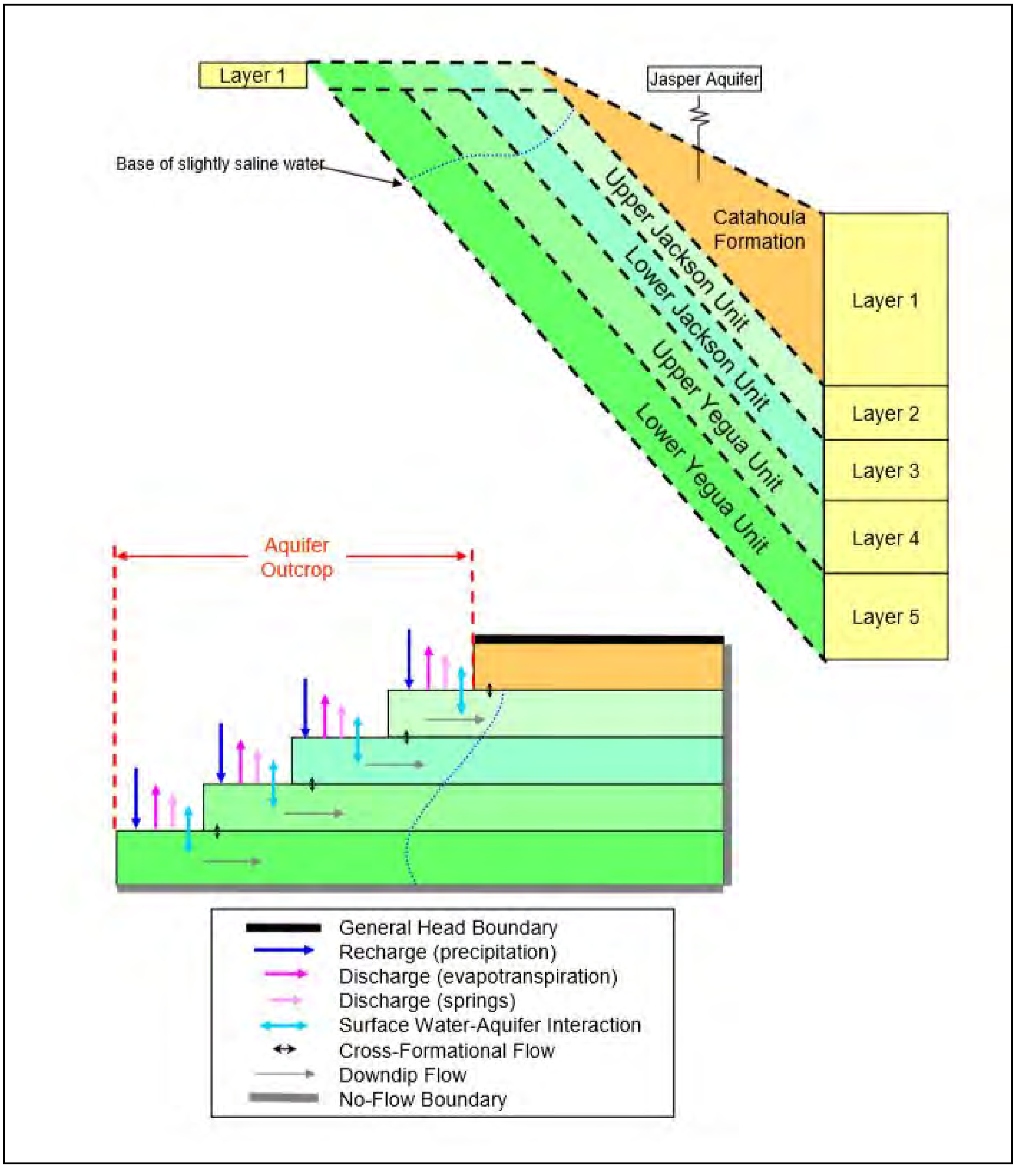

Figure 4-3. Conceptual Flow Model of the Yegua-Jackson Aquifer (from Deeds and others, 2010, Figure 5.0.1)

The first layer represents the shallow outcrop section of the Yegua-Jackson Aquifer and Catahoula Formation. The remaining layers represent, from top to bottom, the Upper Jackson

Unit, the Lower Jackson Unit, the Upper Yegua Unit, and the Lower Yegua Unit. The model was calibrated for two time periods, one representing pre-development conditions (prior to 1900) and the other representing transient conditions (1980 through 1997). Because each model grid block covers 1 square mile, the applicability of the model is limited to regional-scale assessments of groundwater availability. The groundwater pumping and hydraulic properties are averaged over the area of model grid blocks, so at the current scale of the model, it is not capable of predicting aquifer responses at specific locations such as pumping wells. However, the model is applicable for simulating aquifer response at a scale of a few to tens of miles, which is appropriate for the regional planning needs of GMA 12.

4.4 Potential Pumping Scenario Using Yegua-Jackson GAM

The GCDs that comprise GMA 12 developed estimates of potential uses that could occur in the upcoming decades based on existing use and projected future demands. Two well files were developed and the simulation performed to develop DFCs for the period from 2010 through December 2069. The GAM simulations that used the two well files are named YGJK-PS1 and YGJK-PS-2.

Results from GAM Run YGJK-PS1 were presented to GMA 12 during the meeting on November 15, 2019. The future pumping in the well file was nearly identical to the well file used to generate the DFCs in the previous joint planning session. A concern with the GAM Run YGJK-PS1 was that annual production amounts in GMA 12 from 2010 to 2018 were significantly greater than the recorded historical pumping amounts. To address this concern, GAM Run YGJK-PS2 was created wherein the pumping rates from 2010 to 2020 were changed to better reflect historical pumping and the estimates for pumping after 2020 were revised. Results from GAM Run YGJK-PS2 were presented to GMA 12 during the meeting on January 29, 2020. During the meeting, plots of the annual production rates from 2000 to 2070 by GCDs were shown. Table 4-2 provides the average drawdowns simulated using YGJK-PS2.

Table 4-2 Average Aquifer Drawdown Calculated for Yegua-Jackson Aquifer using YGJK-PS2

GCD or County	Average Aquifer Drawdown (feet) measured from January 2010 through December 2069
Brazos Valley GCD	62
Fayette County GCD	81
Lost Pines GCD	--
Mid-East Texas GCD	8
Post Oak Savannah GCD	61
GMA 12	***55***

4.5 Brazos River Alluvium GAM

The proposed DFCs for the Brazos River Alluvium Aquifer (BRAA) were developed based on simulations of future pumping scenarios using the GAM for the BRAA (Ewing and Jigmond, 2016). The BRAA consists of the floodplain and terrace deposits of the Brazos River. The aquifer extends from Bosque and Hill counties in the northwest to Fort Bend County in the southeast portion of the study area. Figure 4-4 shows aerial footprint of the BRAA in GMA 12 and across the rest of Texas. The BRAA is a minor aquifer in Texas that is primarily used for irrigation in GMA 12.

The BRAA GAM was developed using MODFLOW-USG (Panday and others, 2013). Figure 4-5 a west to east cross-section through GMA 12, along with a conceptual block diagram illustrating aquifer layering and sources and sinks for groundwater. The BRAA GAM consists of three layers. Model Layer 1 and Model Layer 2 represent the upper and the lower sections of the Brazos River Alluvium. Model Layer 3 represents the shallow portions of the formations and aquifers underlying the BRAA. The BRAA GAM uses a numerical grid that consists of grid cells that vary from 660 feet square throughout the footprint of the Brazos River Alluvium Aquifer to 5,280 feet square over the majority of the Brazos River Basin.

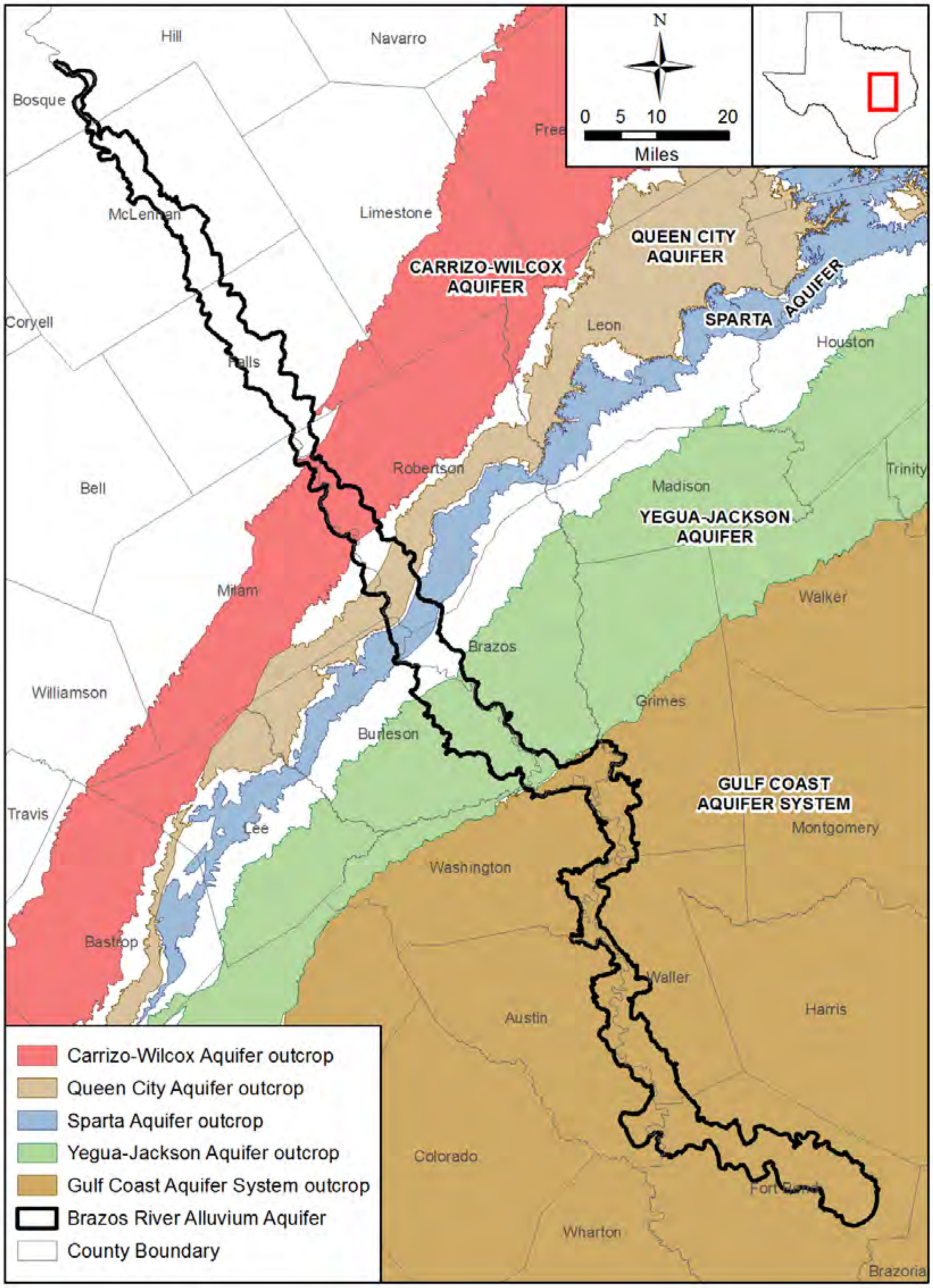

Figure 4-4. Extent of the Brazos River Alluvium Aquifer Groundwater Availability Model (from Ewing and Jigmond, 2016, Figure 1.0.3)

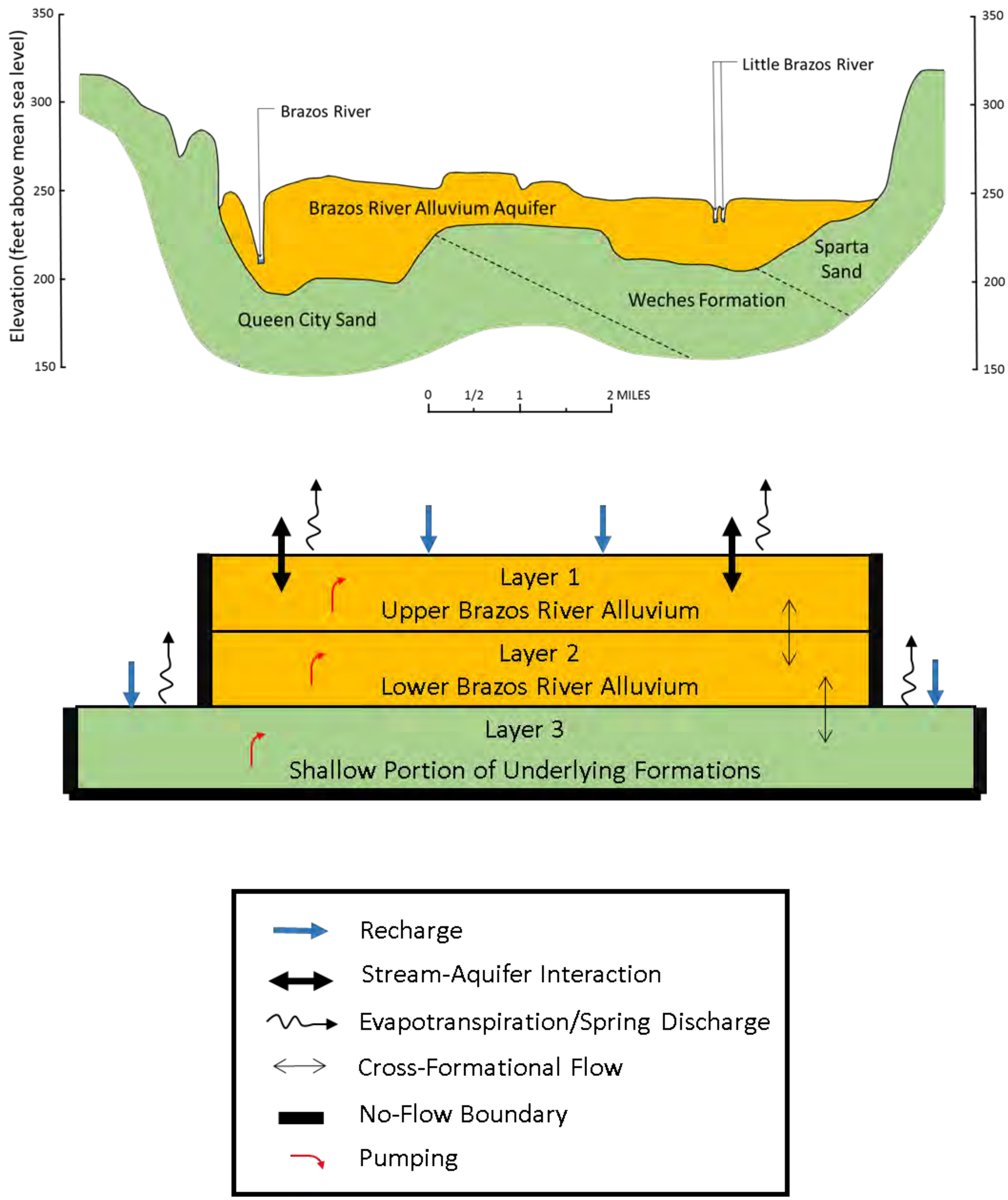

Figure 4-5. Conceptual Groundwater Flow Model (Cross-Sectional View) for the Brazos River Alluvium Aquifer (from Ewing and Jigmond, 2016, Figure 2.0.1)

The BRAA GAM was calibrated using a steady-state stress period that represents predevelopment conditions prior to 1950 and a transient period from 1950 until 2012. From 1950 to 1980, the model uses annual time periods. After 1980, the GAM was calibrated using monthly time periods. In the transient calibration period, discharge to the Brazos River is highly variable from year to year because of the variability in flows within the Brazos River. Nevertheless, a simple trend analysis indicates that discharge from the Brazos River Alluvium Aquifer to perennial streams is decreasing over time.

4.6 Potential Pumping of Brazos River Alluvium

The Brazos River Alluvium Aquifer is primarily used for irrigation in Brazos, Burleson, and Robertson counties and to a much lesser degree for domestic and stock use. The largest volume of pumping occurs during the growing season from about April through September. Outside of the growing season (approximately half the year), there is a very limited amount of pumping from the aquifer. DFCs were developed for the Brazos River Alluvium Aquifer based on static water-level changes that have occurred in screened wells over the past approximately 60 years. The DFCs are based on allowing aquifer users to lower static water levels in wells to essentially the deepest levels previously recorded, as groundwater was still available for pumping when those levels were reached.

The future pumping scenario was created by slightly modifying the pumping well that the TWDB developed to generate a MAG based on the DFCs that GMA 12 adopted for the BRAA in 2017 (Wade, 2017). The MAG was developed based on the following conditions:

- Average streamflow and recharge conditions were assumed for the predictive modeling period of 2013 through 2070.
- The pumping distribution during the predictive model years (2013 through 2070) is based on the average pumping distribution from the last year of the historical model (2012).
- Dry cells do not occur in the groundwater availability model for the Brazos River Alluvium Aquifer; however, pumping is reduced by the model code (MODFLOW USG) to prevent model cells from going dry during the simulation. All reported modeled available groundwater values are extracted from the budget output files rather than from the well file input package and reflect what was actually pumping in the model.

- A tolerance of 1 foot or 5 percent (whichever was greater) was assumed when comparing desired future conditions to average saturated thickness decline or percent saturation values.

GMA 12 modified by pumping rates by adjusting pumping to accommodate two changes. One change was to reduce the pumping from grid cells where the initial pumping rates could not be sustained. The other change was to avoid adding future pumping in the same grid cells that included a river node. The development of the annual production rates was discussed in GMA 12 meetings that occurred on November 15, 2019 and on February 12, 2021. At both meetings, the graphs were provided to show that the change in water levels over time achieved the DFCs expressed in Table 2-3. For accounting purposes, the GMA 12 consultants named the modification of the TWDB MAG simulation that was used to help develop the BRAA DFCs as GAM Run BRAA PS-1.

In 2070, the annual production in the well file for Milam County, Burleson County, Robertson County, and Brazos counties are approximately 38,626 acre-feet per year (ac-ft/yr), 32,306 ac-ft/yr, 52,903 ac-ft/yr, and 76,038 ac-ft/yr, respectively. As a result of the future pumping, the GAM predicts that over the period from 2013 to 2070 the amount of groundwater that contributes to river flow in the four counties is reduced by 37,500 ac-ft/yr. Table 4-3 provides the water balance flow components used to calculate the 37,500 ac-ft/yr. It should be noted that pumping in Brazos and Robertson counties from the BRAA has averaged about 81,000 ac-ft/yr over the last 10 years compared to an assumed pumping of 128,941 ac-ft/yr in the simulation.

Table 4-3. Simulated Changes in the Surface Water-Groundwater Exchange in GAM 12 between the BRAA and the Brazos River in 2013 and 2070

County	Flow from Alluvium to River (ac-ft/yr)		Flow from River to Alluvium (ac-ft/yr)		Net Flow (ac-ft/yr)		Reduction in Groundwater Contribution to River Flow (ac-ft/yr)
	2013	2070	2013	2070	2013	2070	
Milam	-1,158	-741	28,676	33,235	27,518	32,494	4,976
Robertson	-1,049	-741	22,288	27,245	21,240	26,534	5,294
Brazos	-4,305	-3,268	23,738	36,996	19,433	33,728	14,295
Burleson	-2,804	-1,851	22,194	34,206	19,391	32,355	12,964

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4.7 Use of Groundwater Availability Models

The joint groundwater planning process in GMA 12 involved using the three GAMs discussed above in evaluating potential DFCs for the aquifers while also considering the nine factors required by Texas Water Code §36.108(d) (1-8). As discussed previously, several model simulations were performed before adopting desired future conditions for the aquifers.

In using GAMs in the process of developing DFCs, it is necessary to have the amount and areal distribution of pumping as inputs in order to evaluate drawdown values for the various aquifers over a prescribed time. The GAM applications involved an iterative approach that included running several predictive pumping scenarios with the model and then evaluating the results in the process of developing DFCs. This process helps the GMA understand the impacts of varying amounts of pumpage on the aquifers over time. GMA 12's approach is similar to the process undertaken by many GMAs across the state, where GMAs evaluated the relationship between pumping and DFCs prior to finalizing the DFCs. DFCs are policy decisions being made by the GMAs, and it is reasonable and prudent for GMAs to want to understand the ramifications of major policy decisions prior to adopting these policies.

In the case of groundwater management, a scientific method that can include the use of GAMs can be used to understand the relationship between groundwater pumping and drawdown or groundwater pumping and the effects on flow between aquifers. The GAMs are a tool that can be used to run various simulations to better understand the cause and effect relationships within a groundwater system as they relate to groundwater management. A substantial amount of the consideration of the nine statutory factors involves understanding the effects or impacts of DFCs. The effects can include drawdowns, environmental factors, socioeconomic and private property rights. The use of GAMs in the iterative process of the development of DFCs for groundwater management is an effective method for developing information that is a consideration by GMAs or districts as they develop DFCs.

5. Factors Considered for the Desired Future Conditions

This section summarizes some of the information considered by GMA 12 in deliberations and discussions of the DFCs.

5.1 Aquifer Uses and Conditions

Texas Water Code Section 36.108 (d)(1) requires that, during the joint-planning process, GCDs shall consider "aquifer uses or conditions within the management area, including conditions that differ substantially from one geographic area to another." On July 24, 2020, a presentation titled "GMA 12 Aquifer Uses and Conditions Consideration Discussion" was given by GMA 12's hydrogeological consultants. This presentation is included as Appendix L. The following section provides additional information about the aquifer uses or conditions of each major and minor aquifer present within GMA 12 for which DFCs were developed. These aquifers include:

- Carrizo-Wilcox Aquifer, which includes the Carrizo, Calvert Bluff, Simsboro, and Hooper hydrostratigraphic units
- Queen City Aquifer
- Sparta Aquifer
- Yegua-Jackson Aquifer
- Brazos River Alluvium Aquifer

The outcrop for each of these aquifers is shown in Figure 5-1. With the exception of the Brazos River Alluvium, which is a shallow alluvial unit present along the Brazos River, these formations all outcrop from southwest to northeast and dip to the southeast toward the Gulf of Mexico.

Water uses, as defined by the TWDB, include:

- Municipal: includes city-owned, districts, water supply corporations, or other private utilities supplying residential, commercial (non-goods-producing businesses), and institutional (schools, governmental operations), as well as non-surveyed municipal (rural domestic)
- Manufacturing: refers to process water use reported by large manufacturing plants. This is also sometimes referred to as "industrial"
- Livestock
- Irrigated agriculture
- Mining: includes water used in the mining of oil, gas, coal, sand, gravel, and other materials
- Steam-Electric Power: refers to consumptive use of water by large power generation plants

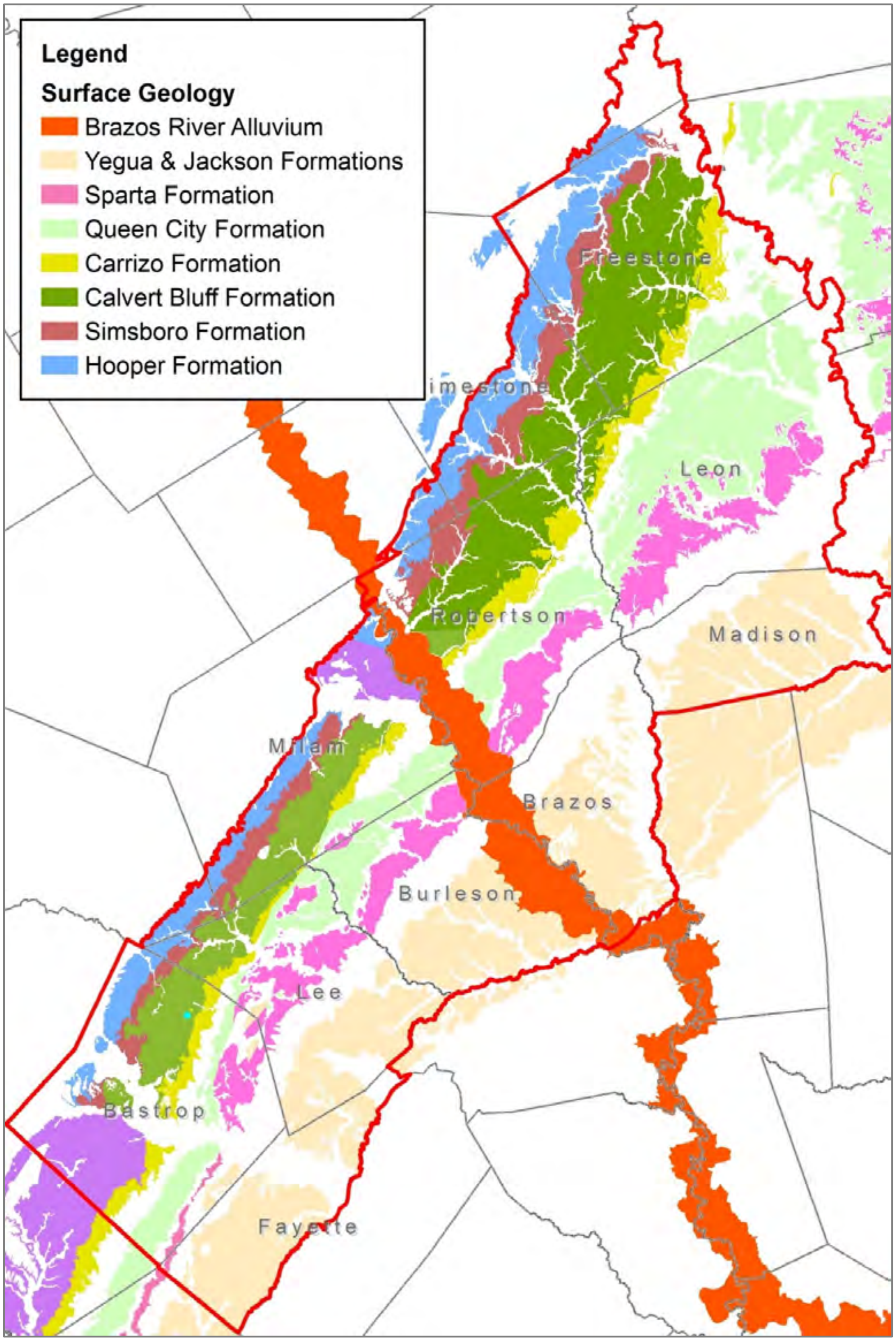

Figure 5-1. Surface Geology of GMA 12

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Within GMA 12, groundwater comprises a significant amount of the total water used. Table 5-1 summarizes the approximate percent of each type of water use that is supplied by groundwater. This table shows that groundwater is the major supplier of water for irrigation, mining, and municipal uses across the GMA, and is a significant supplier for livestock and manufacturing.

Table 5-1 Estimated Historical Overall Water Use Met with Groundwater

Purpose	Lost Pines GCD	Post Oak Savannah GCD	Brazos Valley GCD	Mid-East Texas GCD	Fayette County GCD
Irrigation	100%	99%	90%	100%	90%
Livestock	25%	30%	20%	10%	75%
Manufacturing	100%	89%	100%	0%	30%
Mining	95+%	95+%	80%	50%	60%
Municipal	100%	67%	95%	100%	100%
Steam-Electric	75%	0%	25%	0%	0%

The total reported groundwater production for each GCD in GMA 12 in 2018 is shown in Table 5-2. This table shows the metered/reported volume of groundwater from each of the aquifers. It should be noted that the Fayette County GCD is a member of two different GMAs, and a large portion of Fayette County's overall groundwater production occurs within GMA 15, and therefore is not included in Table 5-2.

Table 5-2. 2018 Metered/Reported Groundwater Production (in acre-feet)

Formation	Lost Pines GCD	Post Oak Savannah GCD	Brazos Valley GCD	Mid-East Texas GCD	Fayette County GCD
Colorado/Brazos River Alluvium	1,252	9,801	127,241	NA	55
Yegua-Jackson	0	152	1,183	9	965
Sparta	225	958	4,309	2,356	0
Queen City	249	313	118	585	163
Carrizo	2,834	1,067	758	1,102	166
Calvert Bluff	1,050	412	193	5,175	NA
Simsboro	18,704	4,932	58,297	1,213	NA
Hooper	677	361	809	3,685	NA
Carrizo-Wilcox	*23,264*	*6,773*	*60,058*	*11,174*	*0*
TOTAL	***24,991***	***17,996***	***192,908***	***14,123***	***1,349***

NA- Not applicable because the aquifer is either not present or not used in that district.

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5.1.1 Carrizo-Wilcox Aquifer

The Carrizo-Wilcox is a major aquifer present across GMA 12, as shown in Figure 5-2. Although the Carrizo-Wilcox is considered a single aquifer system by the TWDB, the individual aquifer units within the Carrizo-Wilcox are used differently within GMA 12 and so they are each summarized separately below. The overall use from the whole Carrizo-Wilcox Aquifer is summarized in Table 5-3. As shown, the Carrizo-Wilcox is heavily used for municipal purposes throughout much of GMA 12, with a few counties also using it extensively for manufacturing, mining, or irrigation.

Table 5-3. Total Estimated Groundwater Production from the Carrizo-Wilcox Aquifer in 2019 (in acre-feet)

County	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
Bastrop	13,228	301	25	5,494	5,455	149	24,652
Brazos	34,273	1.398	0	0	0	0	35,671
Burleson	981	0	0	0	105	10	1,096
Fayette	264	76	0	0	0	8	348
Freestone	1,637	50	0	0	405	138	2,230
Lee	6,277	0	523	0	574	132	7,506
Leon	1,889	660	13	0	304	74	2,940
Madison	99	0	0	0	305	57	461
Milam	2,002	0	0	0	1,616	366	3,984
Robertson	3,165	39	2,969	5,226	7,418	290	19,107

Source: Texas Water Development Board web site, District production records, and District estimates.

* Mining estimate includes Oil & Gas water use as well as surface mining water use reported by the Railroad Commission of Texas (RRC) at the Jewett Mine 32F/47A and the Big Brown Mine for dewatering/pressurization.

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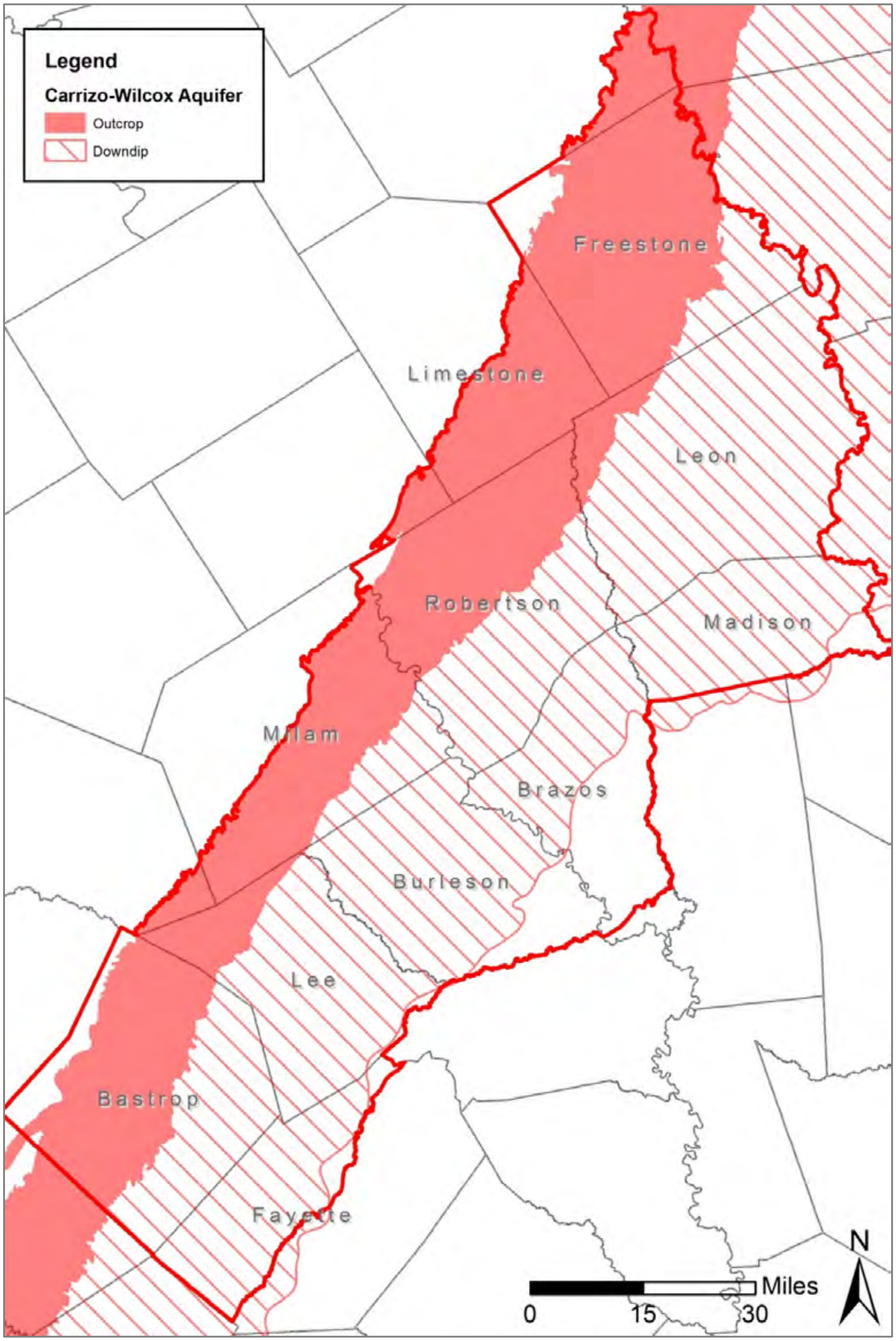

Figure 5-2. Extent of Carrizo-Wilcox Aquifer within GMA 12

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Carrizo Aquifer: The Carrizo Formation is the uppermost hydrostratigraphic unit within the Carrizo-Wilcox Aquifer, and is present through the middle of GMA 12, as shown in Figure 5-3. There has historically been moderate production from the Carrizo across much of GMA 12. Groundwater from the Carrizo is produced from wells shown in Figure 5-3, with some wells up to 2,000 feet deep. Groundwater produced from the Carrizo is primarily used for domestic, livestock, and municipal purposes. Lesser amounts of water from the Carrizo are used for irrigation purposes. Some significant users of water from the Carrizo include the cities of Giddings, College Station, and Smithville, Aqua Water Supply Cooperative (WSC), Lee County WSC, Texas A&M University, the Texas Department of Criminal Justice Ferguson Unit, and several rural WSCs.

Calvert Bluff Aquifer: The Calvert Bluff Formation is found below the Carrizo and is the uppermost of the three Wilcox hydrostratigraphic units within the Carrizo-Wilcox Aquifer. The Calvert Bluff is present through the middle of GMA 12, as shown in Figure 5-4. There has historically been moderate production from the Calvert Bluff across much of GMA 12. Groundwater from the Calvert Bluff is produced from wells shown in Figure 5-4, with most of the wells shallow (less than 800 feet deep). Groundwater produced from the Calvert Bluff is primarily used for domestic and livestock purposes. Lesser amounts of water from the Calvert Bluff is used for municipal and oil and gas drilling purposes. Some significant users of water from the Calvert Bluff include the Bastrop County WCID#2, numerous WSCs in the Mid-East Texas GCD, Nucor Steel, and numerous landowners using the aquifer for domestic and livestock purposes.

Simsboro Aquifer: The Simsboro Formation is found below the Calvert Bluff and is the middle of three Wilcox hydrostratigraphic units within the Carrizo-Wilcox Aquifer. The Simsboro is present through the middle of GMA 12, as shown in Figure 5-5. There has historically been significant production from the Simsboro across much of GMA 12. Groundwater from the Simsboro is produced from wells shown in Figure 5-5, with some of these wells very deep (up to 3,000 feet). The Simsboro can be a very productive aquifer in about the western three-quarters of the GMA, making it the target for groundwater development projects in many areas of GMA 12. Groundwater produced from the Simsboro is primarily used for municipal purposes as well as historically for mine depressurization. Lesser amounts of water from the Simsboro are used for industrial, livestock, and irrigation purposes. Some significant users of water from the Simsboro include the cities of Bryan/College Station and Elgin, Manville and Aqua WSCs, several WSCs in

Mid-East Texas GCD, the LCRA, Texas A&M University, NRG Texas Power, Major Oak Power, and landowners throughout the GMA.

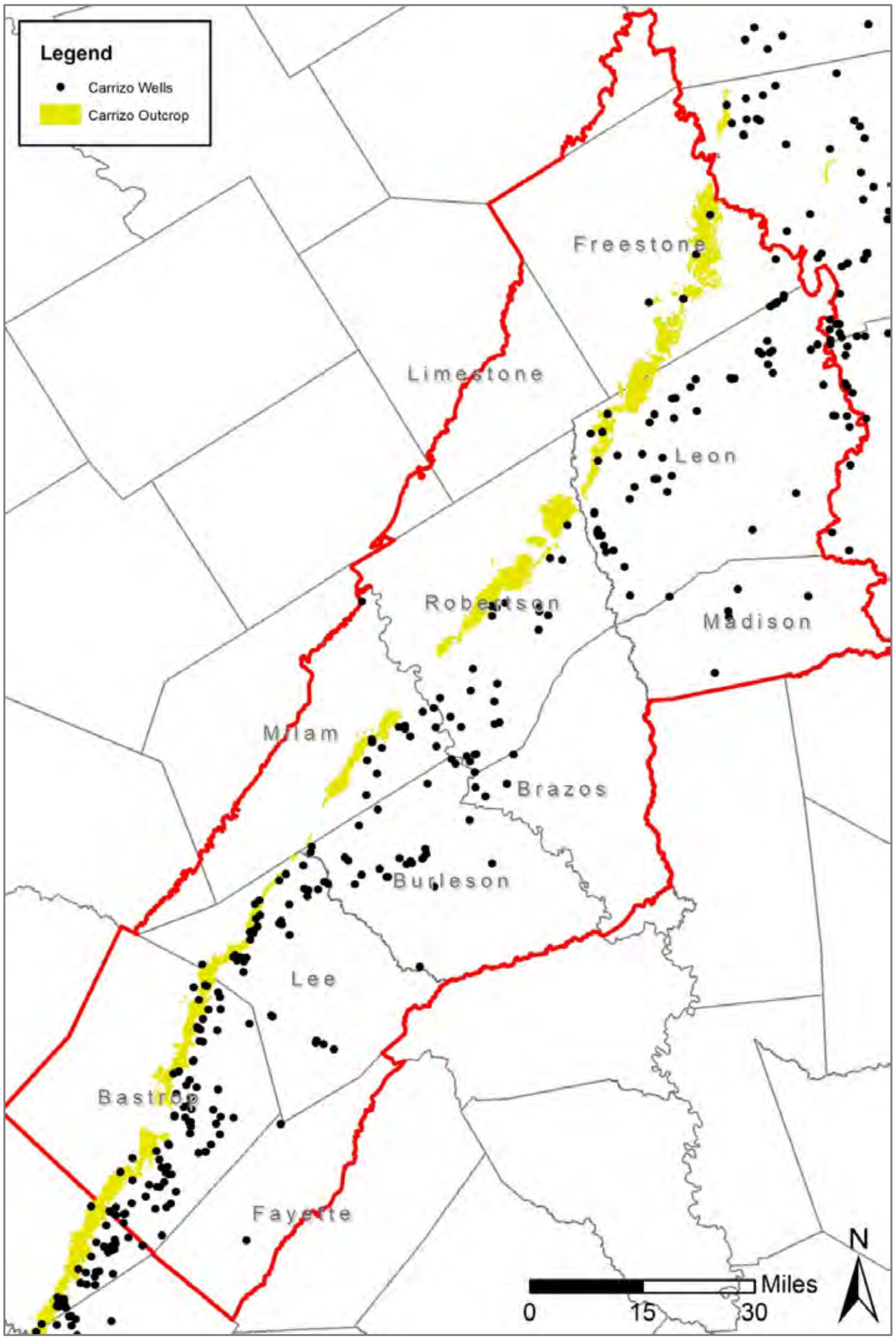

Figure 5-3. Extent of Carrizo Aquifer within GMA 12

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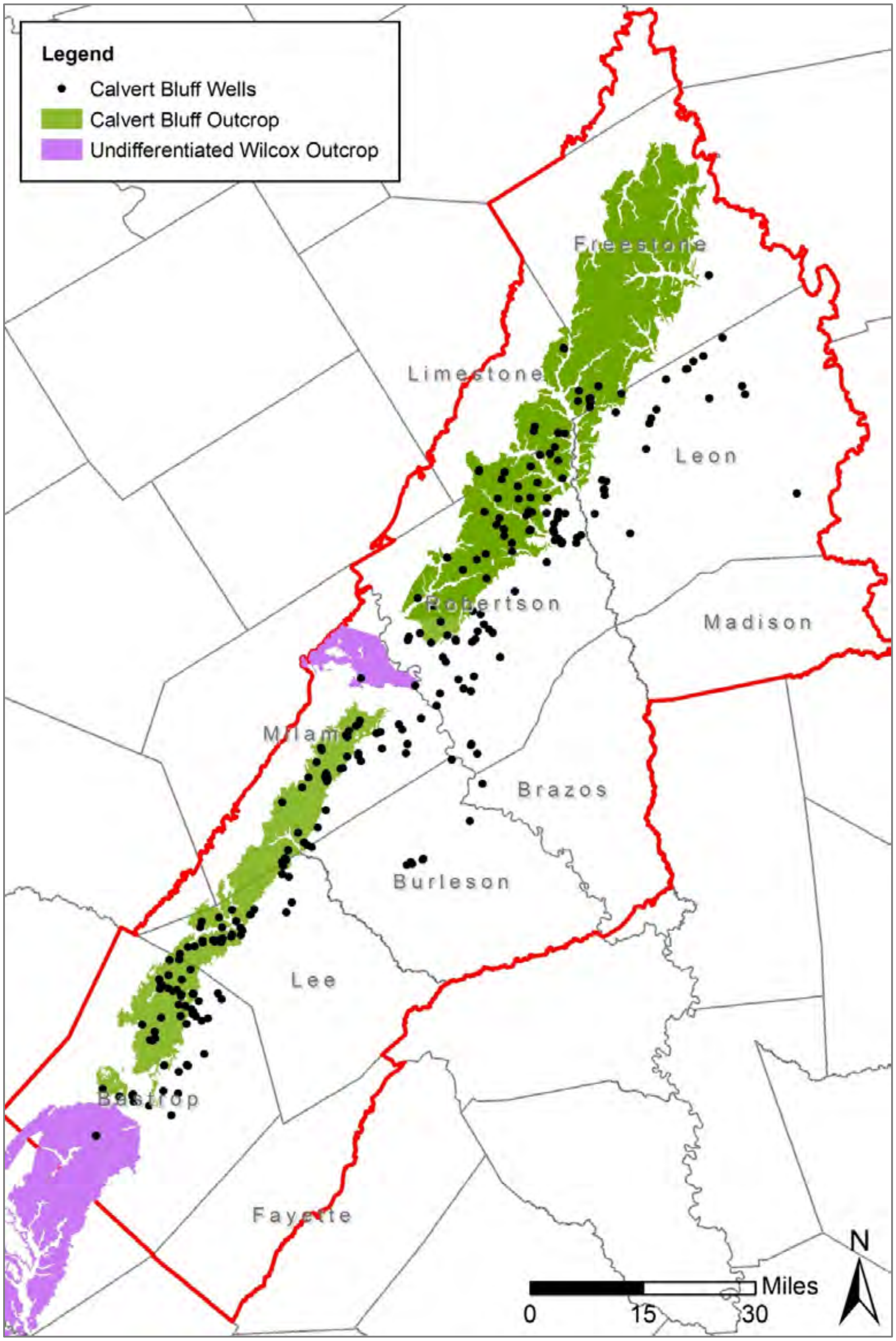

Figure 5-4. Extent of Calvert Bluff Aquifer within GMA 12

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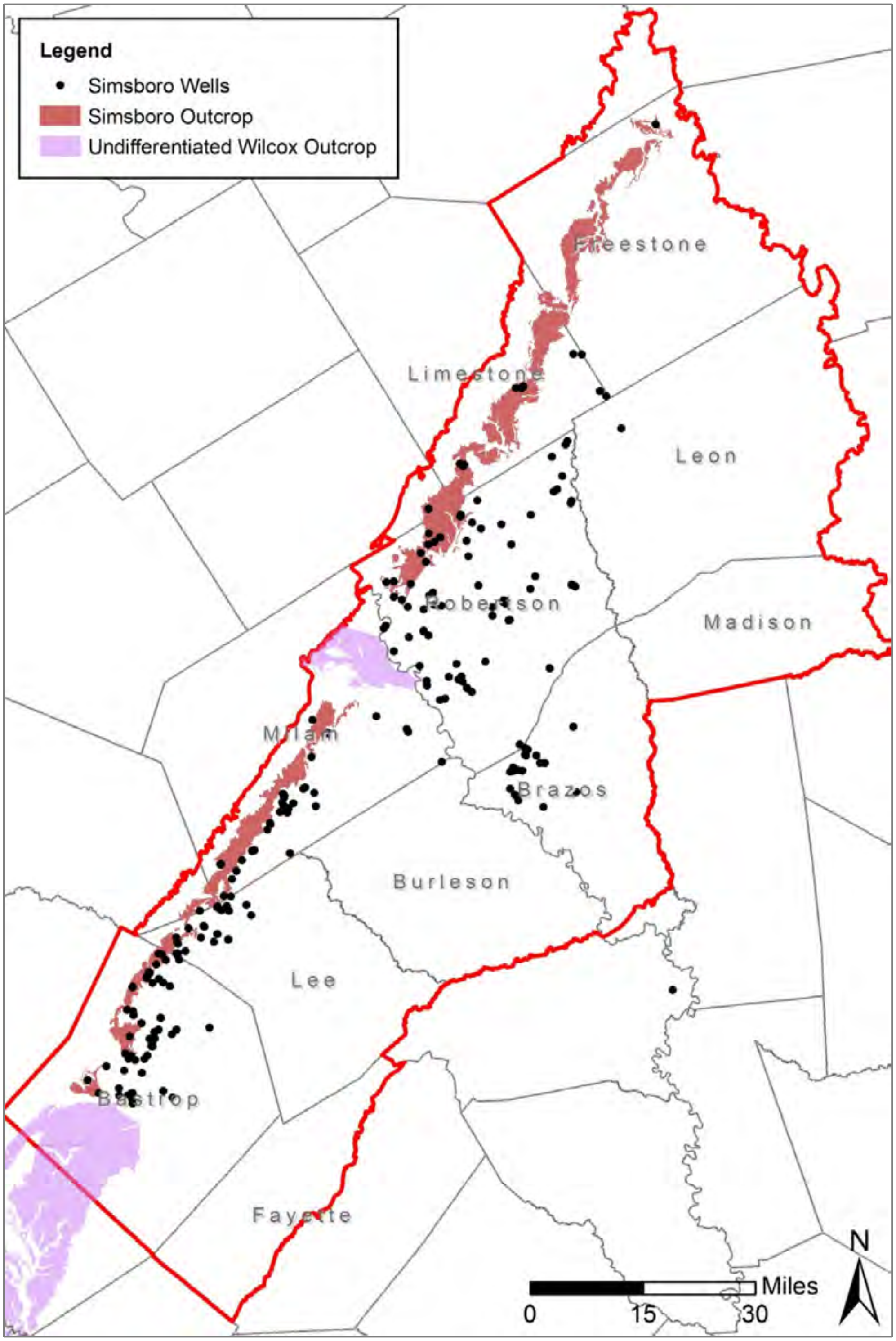

Figure 5-5. Extent of Simsboro Aquifer within GMA 12

Hooper Aquifer: The Hooper Formation is found below the Simsboro and is the lowermost of the three Wilcox hydrostratigraphic units within the Carrizo-Wilcox Aquifer. The Hooper is present across the northwestern edge of GMA 12, as shown in Figure 5-6. There has historically been little production from the Hooper across much of GMA 12. Groundwater from the Hooper is produced from wells shown in Figure 5-6, with most of the wells shallow (less than 500 feet deep) in and near the Hooper outcrop. Groundwater produced from the Hooper is primarily used for domestic and livestock purposes. Lesser amounts of water from the Hooper are used for municipal and power generation purposes. Some significant users of water from the Hooper include the cities of Bremond, Fairfield, Hutto, and Teague, and the TDCJ Boyd Unit.

5.1.2 Queen City Aquifer

The Queen City Aquifer is a minor aquifer present through the middle of GMA 12, as shown in Figure 5-7. Groundwater production from the Queen City in 2019 is summarized in Table 5-4. As shown in this table, there is only limited use across most of GMA 12. Groundwater from the Queen City is primarily produced from shallow to moderately deep wells, with most wells less than 1,000 feet deep, but a few up to 2,000 feet. Groundwater produced from the Queen City is primarily used for domestic/municipal, livestock, and irrigation purposes. Some significant users of water from the Queen City include some rural WSCs in Mid-East Texas GCD, the Town of Lincoln, and numerous landowners for livestock and domestic purposes.

Table 5-4. Total Estimated Groundwater Production from the Queen City Aquifer in 2019 (in acre-feet)

County	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
Bastrop	5	0	0	0	1,095	33	1,133
Brazos	65	0	268	0	0	31	364
Burleson	410	0	0	0	0	102	512
Fayette	103	0	0	0	0	0	103
Freestone	7	0	0	0	0	10	17
Lee	214	0	0	0	568	149	931
Leon	285	62	0	0	0	44	391
Madison	52	0	0	0	0	0	52
Milam	9	0	0	0	647	19	675
Robertson	0	0	0	0	68	75	143

Source: Texas Water Development Board web site, District production records, and District estimates.

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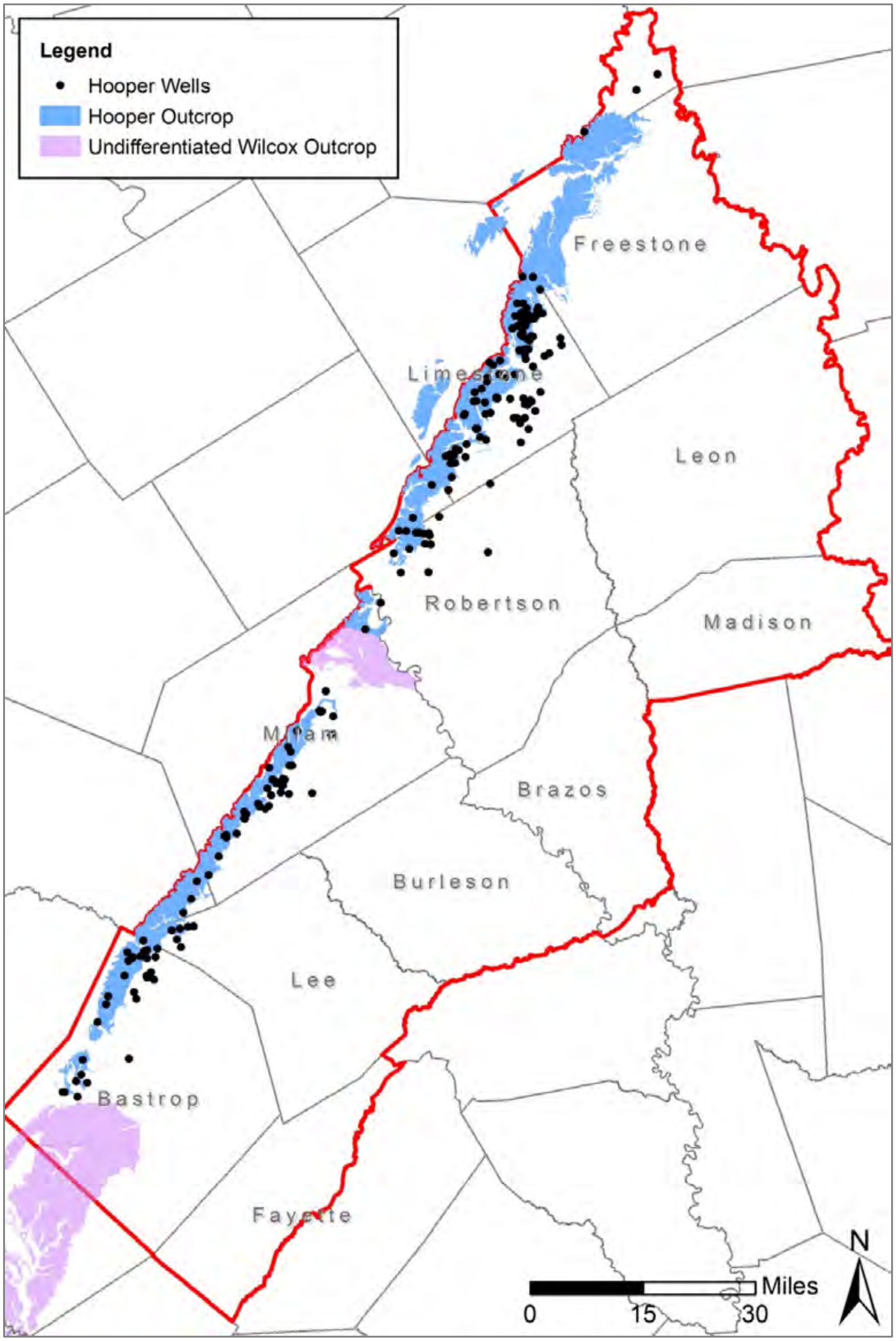

Figure 5-6. Extent of Hooper Aquifer within GMA 12

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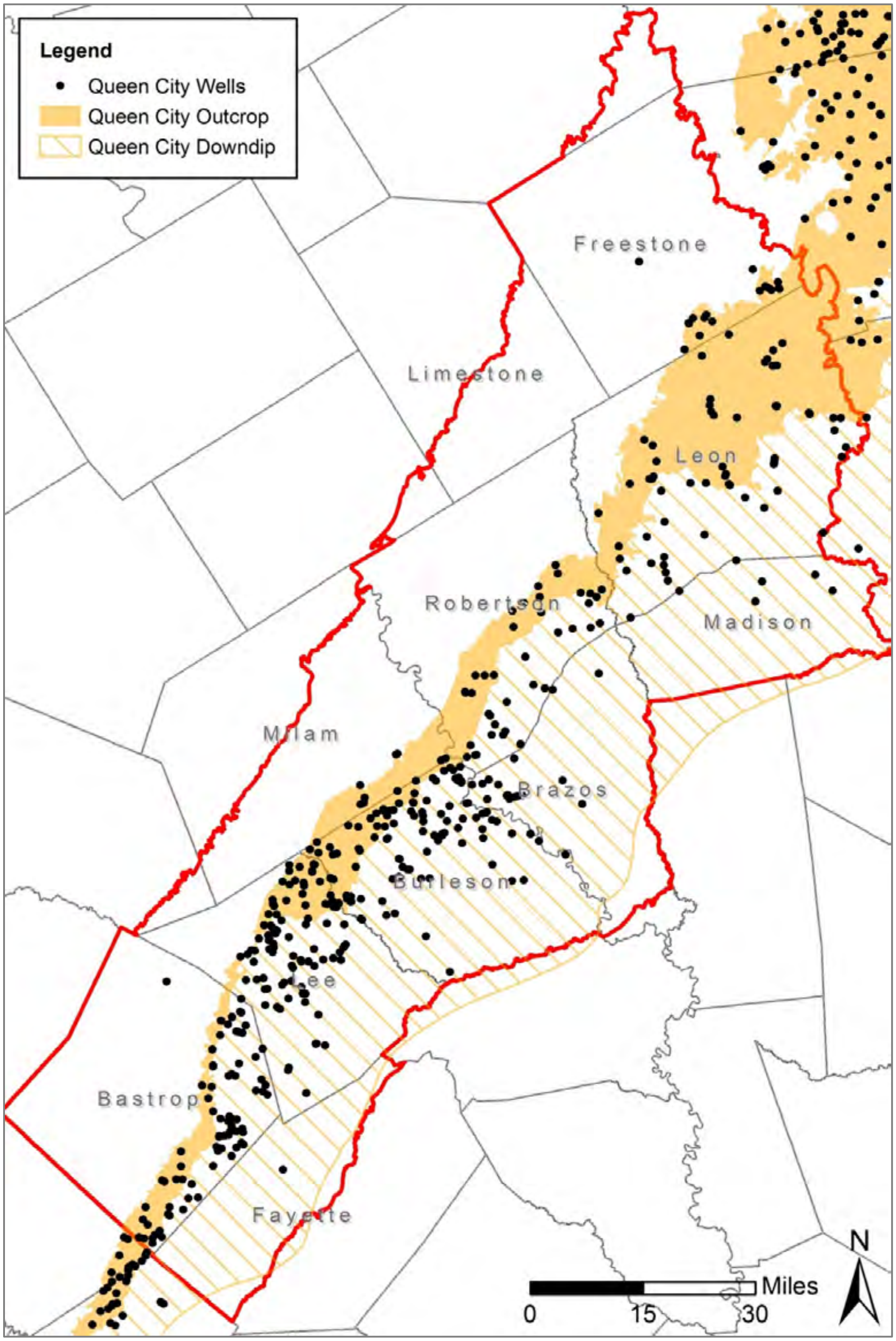

Figure 5-7. Extent of Queen City Aquifer within GMA 12

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5.1.3 Sparta Aquifer

The Sparta Aquifer is a minor aquifer present through the middle of GMA 12, as shown in Figure 5-8. Groundwater production from the Sparta in 2019 is summarized in Table 5-5. As shown in this table, there is some use from this aquifer in Brazos, Burleson, and Madison counties, with significantly less use from this aquifer in the rest of the GMA. Groundwater from the Sparta is primarily produced from shallow to moderately deep wells, with most wells less than 1,000 feet deep, but a few up to 2,000 feet. Groundwater produced from the Sparta is primarily used for domestic/municipal, livestock, and irrigation purposes. It is also used for manufacturing in a few counties. Some significant users of water from the Sparta include the City of Madisonville and several municipalities and WSCs in Brazos and Lee counties.

Table 5-5. Total Estimated Groundwater Production from the Sparta Aquifer in 2019 (in acre-feet)

County	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
Bastrop	1	0	0	0	260	24	285
Brazos	2,377	0	764	62	570	115	3,888
Burleson	734	3	0	0	0	63	800
Fayette	96	0	0	0	176	10	282
Lee	202	0	0	0	0	51	253
Leon	23	0	0	0	0	8	31
Madison	2,753	0	0	0	185	25	2,963
Robertson	19	5	0	0	104	76	204

Source: Texas Water Development Board web site, District production records, and District estimates.

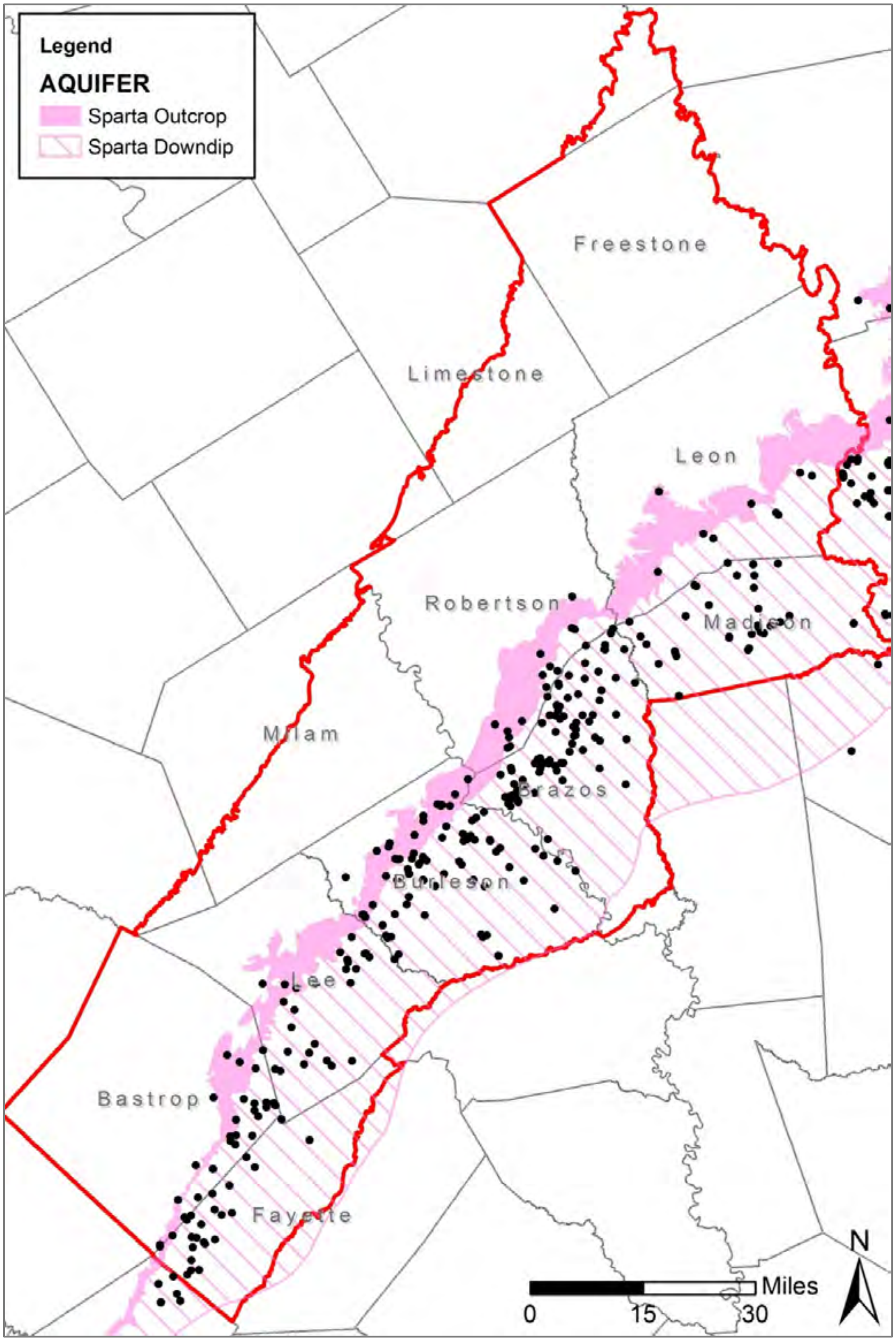

Figure 5-8. Extent of Sparta Aquifer within GMA 12

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5.1.4 Yegua-Jackson Aquifer

The Yegua-Jackson Aquifer is a minor aquifer present in the southeastern third of GMA 12, as shown in Figure 5-9. Groundwater production from the Yegua-Jackson in 2019 is summarized in Table 5-6. As shown in this table, there is some production from this aquifer in Brazos and Fayette counties, with significantly less production from this aquifer in the rest of the GMA. Groundwater from the Yegua-Jackson is primarily produced from shallow wells, and is largely used for domestic/municipal, livestock, and irrigation purposes. Lesser amounts of water from the Yegua-Jackson are used for mining (oil and gas drilling). Some significant users of water from the Yegua-Jackson include several municipalities in Fayette County and golf course irrigation and some industrial users in Brazos Valley GCD.

Table 5-6 Total Estimated Groundwater Production from the Yegua-Jackson Aquifer in 2019 (in acre-feet)

County	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
Bastrop	0	0	0	0	0	3	3
Brazos	717	286	0	0	262	254	1,519
Burleson	281	0	0	0	52	102	435
Fayette	1,183	0	0	0	161	30	1,374
Lee	1	0	0	0	0	28	29
Madison	157	0	0	0	0	19	176

Source: Texas Water Development Board web site, District production records, and District estimates.

5.1.5 Brazos River Alluvium Aquifer

The Brazos River Alluvium Aquifer is a minor aquifer present along the Brazos River between Brazos Valley GCD (Brazos and Robertson counties) and Post Oak Savannah GCD (Burleson and Milam counties), as shown in Figure 5-10. Groundwater is produced from the Brazos River Alluvium entirely from very shallow (less than 100 feet) wells, and is used almost entirely for irrigation purposes. Overall reported use is much higher in Brazos Valley GCD than in Post Oak Savannah GCD, as shown in Table 5-7.

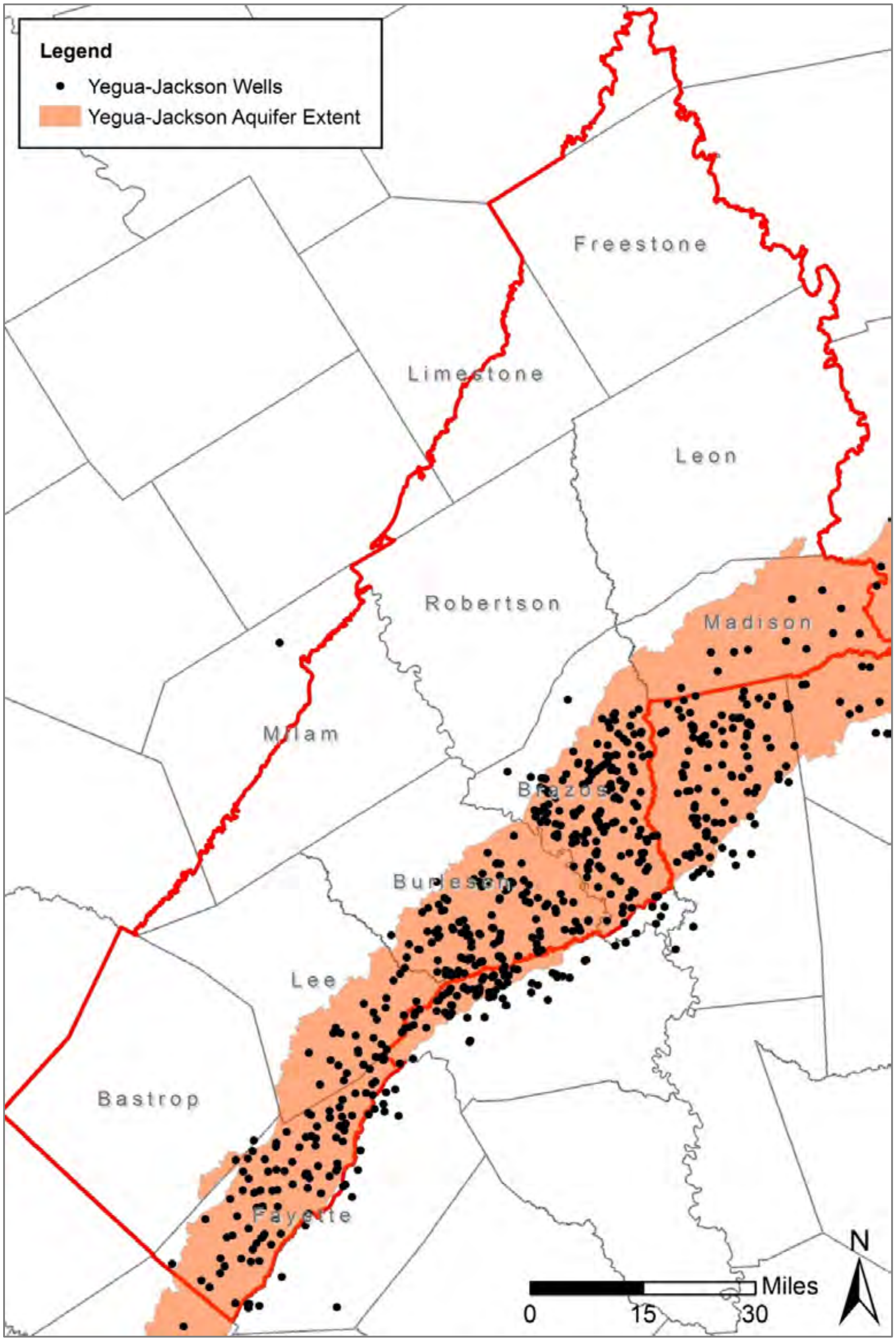

Figure 5-9. Extent of Yegua-Jackson Aquifer within GMA 12

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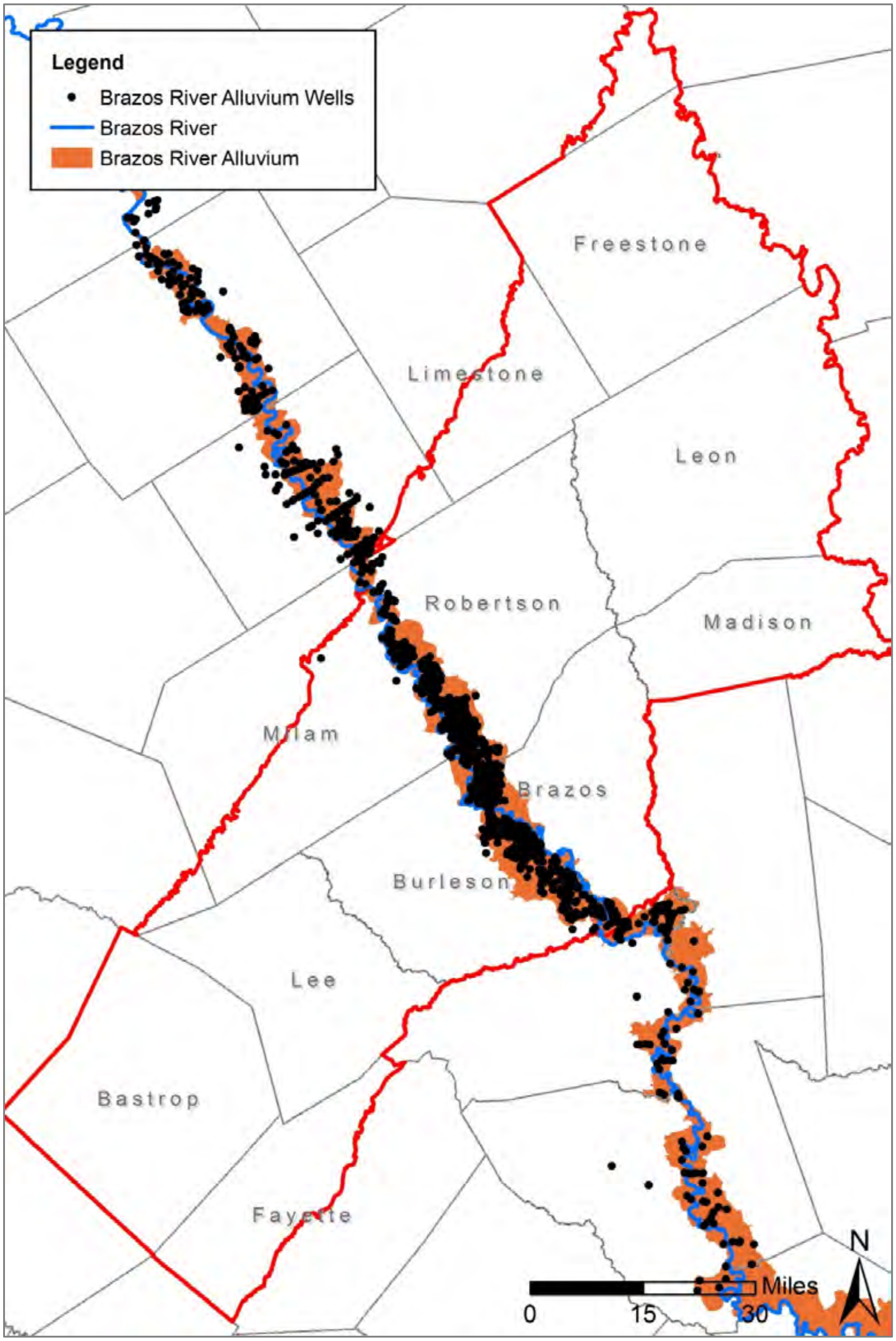

Figure 5-10. Extent of Brazos River Alluvium Aquifer within GMA 12

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Table 5-7. Total Estimated Groundwater Production from the Brazos River Alluvium Aquifer in 2019 (in acre-feet)

County	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
Brazos	0	0	0	0	31,085	0	31,085
Burleson	0	0	0	0	13,490	0	13,490
Robertson	0	0	0	0	52,760	89	52,849

Source: Texas Water Development Board web site

5.1.6 Trinity Aquifer

The Trinity Aquifer is present in GMA 12 only in a very small area in Bastrop, Lee, and Williamson counties. There is no historical use within GMA 12, and no known wells within the GMA. It is found only at very great depths, and was declared "not relevant" for the purposes of joint planning in GMA 12 on February 12, 2021.

5.2 Water Supply Needs and Water Management Strategies

Texas Water Code Section 36.108 (d)(2) requires that, during the joint-planning process, GCDs shall consider "the water supply needs and water management strategies included in the state water plan." For the current joint-planning process, GMA 12 relied on the draft 2021 Regional Water Plans for Regions G, K, C, and H to provide estimates of future water needs and water management strategies within the GMA. It should be noted that during the development of the proposed DFCs, the 2022 State Water Plan was not available and the draft regional water plans was the most current available information. The State Water Plan is a combination of regional water plans created by regional planning groups across the state. Portions of GMA 12 fall within Regional Water Planning Areas C, G, H, and K. GCD representatives from GMA 12 regularly attended the planning meetings for areas C, G, H, and K, and thus were able to provide some insight into the unpublished (at the time) 2022 State Water Plan for consideration during the DFC development process.

The overall water needs for a region, as defined within the Texas State Water Plan, are the demands that cannot be met with existing supplies. The "demands" are based on water demand projections developed during the water planning process for the six major water use sectors: municipal, manufacturing, mining, steam-electric, irrigation, and livestock. Existing supplies may be inadequate to satisfy projected demands due to natural conditions (e.g., sustainable supply of an aquifer or firm yield of a reservoir) or infrastructure limitations (e.g., inadequate diversion, treatment, or transmission capacity). On July 24, 2020, a presentation titled "GMA 12: Needs and Strategies" was given by GMA 12's hydrogeological consultants. This presentation is included as Appendix G. The presentation discussed the supply, demand, surplus/need, and water management strategies for each groundwater conservation district in GMA 12.

A review of the water management strategies within a region gives some insight into the potential future supply for meeting identified needs. Table 5-8 provides Regional Planning Values for 2070 for the five GCDs that comprise GMA 12. The total groundwater and surface water supplies for the five GCDs are 471,714 ac-ft/yr, of which 65% are groundwater supplies. The projected 2070 water demand for the five GCD is 554,103 ac-ft/yr and the 2070 projected water need is 111,375 ac ft/yr. The proposed water management strategies identify projects for the five GCDs will generate 111,551 ac-ft/yr of water in 2070. Thus, the management strategies provide sufficient additional water to meet the projected needs for the five GCDs.

For 2070, the regional water plans presume that the groundwater source and the groundwater strategies for the five GMA 12 GCDs are 305,401 ac-ft/yr and 33,401 ac-ft/yr, respectively. The sum of the groundwater sources and water strategies is 338,783 ac-ft/yr. Table 5-9 lists the amounts of the current operating permits in the five GCDs. These permits total 635,671 ac-ft/yr. Thus, GMA 12 GCDs currently have allocated approximately 300,000 ac-ft/yr more than is anticipated by the regional plans to meet groundwater demands.

Based on this review, GMA 12 determined that the proposed DFCs are not anticipated to have a significant impact on the water supplies, water supply needs, or water management strategies of the 2022 State Water Plan. This evaluation of water supply was considered during the GMA 12 deliberations on how to provide a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging and prevention of waste of groundwater in the management area.

Table 5-8. Regional Water Plan Amounts for Supplies, Demands, and Strategies in 2070 for GMA 12 GCDs (in acre-feet)

	Post Oak Savannah GCD	Mid-East Texas GCD	Lost Pines GCD	Fayette County GCD	Brazos Valley GCD
SUPPLY (Groundwater & Surface Water)					
Other	960	2,923	3,592	878	585
Irrigation	33,052	1,483	5,448	1,022	107,825
Livestock	4,151	5,517	2,351	1,982	4,291
Manufacturing	125	945	223	402	7,475
Mining	2,089	1,840	476	1,629	17,327
Municipal	10,917	7,419	58,723	4,774	54,803
Steam Electric Power	-	24,980	10,288	44,912	46,307
TOTAL	***51,294***	***45,107***	***81,101***	***55,599***	***238,613***
DEMAND					
Other	954	4,555	3,592	1,606	528
Irrigation	33,306	1,183	5,448	828	119,410
Livestock	4,151	5,517	2,351	1,726	4,291
Manufacturing	130	1,088	223	442	1,831
Mining	442	6,410	476	350	12,814
Municipal	8,024	10,984	58,723	4,383	85,865
Steam Electric Power	32,254	34,432	10,288	49,211	46,287
TOTAL	***79,261***	***64,169***	***81,101***	***58,546***	***271,026***
SURPLUS/NEED					
Other	6	-1,632	1	-728	57
Irrigation	-254	300	231	194	-11,585
Livestock	-	-	42	256	-
Manufacturing	-5	-143	10	-40	5,644
Mining	1,647	-4,570	5,044	1,279	4,513
Municipal	2,893	-3,565	-34,314	391	-31,062
Steam Electric Power	-32,254	-9,452	-	-4,299	20
TOTAL	***-27,967***	***-19,062***	***-28,986***	***-2,947***	***-32,413***

Table 5-9. Existing Operating Permits for Groundwater Production in GMA 12

Groundwater Conservation District	Existing Permits
Brazos Valley GCD	259,457
Fayette County GCD	36,179
Lost Pines GCD	138,084
Mid-East Texas GCD	19,787
Post Oak Savannah GCD	161,968
Total	***615,205***

5.3 Hydrological Conditions

Texas Water Code Section 36.108 (d)(3) requires that, during the joint-planning process, GCDs shall consider "hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the executive administrator, and the average annual recharge, inflows, and discharge." On January 29, 2020, a presentation titled "GMA 12: Hydrological Conditions Consideration Discussion" was given by GMA 12's hydrogeological consultants. This presentation is included as Appendix N. The presentation discussed the hydrologic conditions in each aquifer in GMA 12. This section summarizes the hydrological conditions for each of the major and minor aquifers present within GMA 12 for which DFCs were developed. These aquifers include:

- Carrizo-Wilcox Aquifer, which includes the Carrizo, Calvert Bluff, Simsboro, and Hooper hydrostratigraphic units
- Queen City Aquifer
- Sparta Aquifer
- Yegua-Jackson Aquifer
- Brazos River Alluvium Aquifer

In this section, we also will provide a discussion on the total estimated recoverable storage (TERS) values provided by the TWDB to GMA 12, as well as the annual average recharge, inflows, and discharge estimates provided to each GCD in the GMA by the TWDB in support of the development of each GCD's management plan.

5.3.1 Geology and Hydrogeology

The aquifers for which DFCs were developed in GMA 12 consists of, from oldest to youngest, the Carrizo-Wilcox, Queen City, Sparta, Yegua-Jackson, and Brazos River Alluvium aquifers. The outcrop for each of these aquifers is shown in Figure 5-1. With the exception of the Brazos River Alluvium, which is a shallow alluvial unit present along the Brazos River, these formations are composed of layers of partially consolidated sands, silts, and clays and all outcrop from southwest to northeast, and dip to the southeast towards the Gulf of Mexico.

5.3.1.1 Carrizo-Wilcox Aquifer

The largest and most productive unit in GMA 12 is the Carrizo-Wilcox Aquifer. This aquifer system contains four separate and distinct hydrostratigraphic units within most of GMA 12. From oldest to youngest, the hydrostratigraphic units comprising the Carrizo-Wilcox Aquifer are the Hooper, Simsboro, Calvert Bluff, and Carrizo aquifers. These individual aquifers are identifiable through most of GMA 12 where the Simsboro is present as a hydrostratigraphic unit and acts as a readily identifiable divider. However, the Simsboro is absent south of the Colorado River and north of the Trinity River, so the Hooper and Calvert Bluff sediments there are simply lumped together as undifferentiated Wilcox Group sediments. Figure 5-11 shows a generic cross-section of the Carrizo-Wilcox Aquifer in the GMA 12 area. Each of the hydrostratigraphic units within the Carrizo-Wilcox Aquifer System is described separately below.

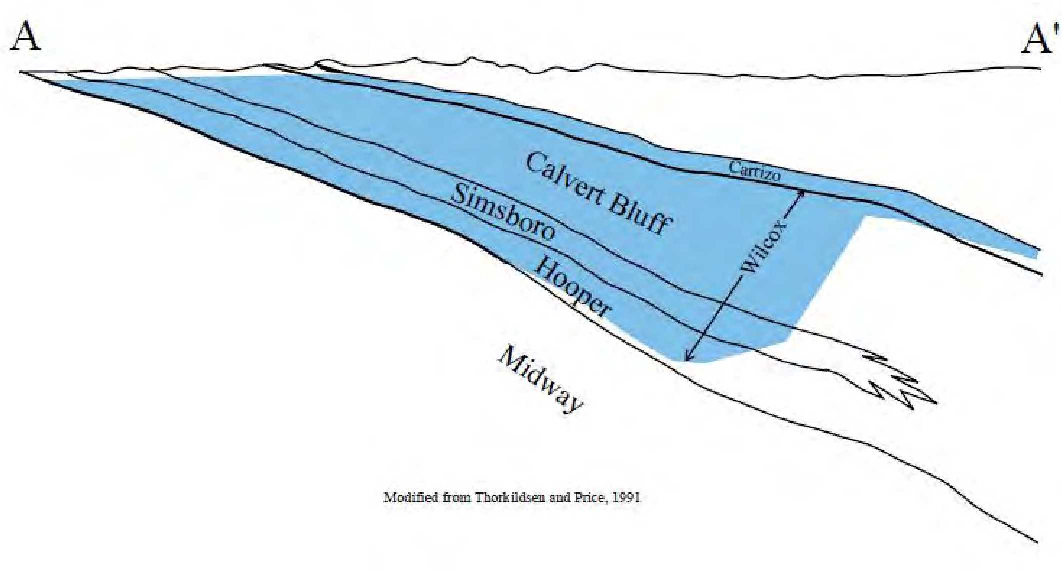

Figure 5-11. Generic Cross-Section of the Carrizo-Wilcox Aquifer in GMA 12 (modified from Ashworth and Hopkins, 1995)

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Carrizo Formation: The uppermost hydrostratigraphic unit in the Carrizo-Wilcox Aquifer is the Carrizo Formation. This hydrostratigraphic unit consists of fine to coarse-grained massive, well-sorted sand (Thorkildsen and Price, 1991; Rogers, 1967). The Carrizo occurs under unconfined conditions in the outcrop area and under confined conditions downdip. As with the three Wilcox hydrostratigraphic units, most groundwater development in the Carrizo Formation occurs in and near the outcrop, but fresh groundwater has been produced from the Carrizo as far downdip as Fayette County, as shown in Figure 5-3. The Carrizo is also a much more extensive unit, with significant production occurring from it across the state. The Carrizo is a highly productive unit to the south in GMA 12, where water developers have installed and are planning on installing large-volume well fields. Water quality in the Carrizo Aquifer has typically been considered fresh to moderately saline. A recently installed municipal well by the Fayette Water Supply Corporation produces significant quantities of groundwater at over 1,200 gallons per minute (gpm) with a total dissolved solids (TDS) concentration of approximately 230 milligrams per liter (mg/L).

Calvert Bluff Formation: The Calvert Bluff Formation is the uppermost of the three Wilcox units and is found directly below the Carrizo. This hydrostratigraphic unit consists of fine- to coarse-grained sandstones interbedded with varying amounts of finer grained sediments as well as some lignite beds (Thorkildsen and Price, 1991). The Calvert Bluff can be up to 2,000 feet thick, and although not as productive as the Simsboro, it can be very productive in limited areas (Thorkildsen and Price, 1991). Most of the development of groundwater from the Calvert Bluff is in the area within about 8 to 10 miles of the outcrop, as shown in Figure 5-4. A few deeper wells are found in the downdip areas, but most wells producing from this unit are relatively shallow.

Simsboro Formation: The next aquifer below the Calvert Bluff is the Simsboro Formation. This hydrostratigraphic unit is identifiable as a separate unit only in GMA 12. The Simsboro is composed of fine- to coarse-grained sand with only small amounts of finer sediments (Thorkildsen and Price, 1991). The Simsboro can be up to 800 feet thick and highly productive. The Simsboro is well developed in and near the outcrop, but it is also highly productive and mainly used downdip (Figure 5-5), with many high capacity wells completed to screen depths of 1,000 to 3,000 feet. Most of the Wilcox pumpage in GMA 12 is from the Simsboro, and it is the unit that is typically targeted for groundwater development in the region.

Hooper Formation: The oldest and deepest unit producing groundwater in GMA 12 is the Hooper Formation. This hydrostratigraphic unit is below the Simsboro and is the deepest of the three main hydrostratigraphic units that make up the Wilcox Aquifer in the region. The Hooper consists primarily of mudstone with some fine- to medium-grained sandstone. In GMA 12 the Hooper can be more than 1,300 feet thick, but is generally less than 500 feet thick in the updip areas where groundwater development typically occurs (Thorkildsen and Price, 1991). It is the least productive of the hydrostratigraphic units within the Carrizo-Wilcox Aquifer, with most development occurring in and near the outcrop, as shown in Figure 5-6. In some areas, however, the Hooper can be moderately productive.

5.3.1.2 Queen City Aquifer

Above the Carrizo-Wilcox Aquifer, separated by the Reklaw Formation, is the Queen City Aquifer. This aquifer is formed by the Queen City Sand, which is a loosely cemented, Tertiary-aged, very-fine-grained sandstone interbedded with silt and silty shale (LBG-Guyton, 2003; George and others, 2011; Kelley and others, 2004; Follett, 1974). Like the other aquifers in the GMA, the Queen City Aquifer occurs under unconfined conditions in the outcrop area and under confined conditions downdip. And as with the other GMA 12 aquifers, much of the groundwater development in the Queen City has occurred in and near the outcrop, but some development in the downdip areas also has occurred, as shown in Figure 5-7. Recharge occurs within the outcrop areas. Water quality in the Queen City Aquifer is mostly fresh to slightly saline within GMA 12, with increasing salinity farther downdip. The Queen City Aquifer can yield small to moderate quantities of water to wells.

5.3.1.3 Sparta Aquifer

Above the Queen City Aquifer, separated by the Weches Formation, is the Sparta Aquifer. This aquifer is formed by the Sparta Sand, which is a massive to cross-bedded, generally well-sorted, fine- to medium-grained sand with some thin interbeds of clay and silt throughout. The Sparta Aquifer occurs under unconfined conditions in the outcrop area and under confined conditions downdip. Recharge occurs within the outcrop areas. Fresh water usually occurs in and near the outcrop areas, and water quality deteriorates with depth. Much of the development of groundwater resources from the Sparta has occurred in and near the outcrop, with some wells producing water in the downdip areas within about 15 miles of the outcrop, as shown in Figure 5-8. The saturated thickness of the Sparta aquifer averages about 120 feet and will yield small to moderate quantities of fresh to moderately saline water to wells in GMA 12 (LBG-Guyton, 2003; George and others, 2011; Kelley and others, 2004; Follett, 1974).

5.3.1.4 Yegua-Jackson Aquifer

The uppermost of the dipping coastal aquifers in GMA 12 is the Yegua-Jackson Aquifer. This aquifer is formed by the Yegua Formation and the Jackson Group, which consist of beds of clay, silt, sand, and shale, with some lignite and gypsum. The Yegua-Jackson Aquifer outcrops through most of the lower third of GMA 12, as shown in Figure 5-9. The aquifer occurs under water table conditions in the outcrop areas and artesian conditions in the deeper portions of the aquifer. Water quality in the Yegua-Jackson is highly variable due to the nature of the sediments that make up the aquifer matrix. Fresh to moderately saline groundwater can be found in many areas, but the groundwater generally becomes more saline with increasing depth. The more productive sand units within the Yegua-Jackson tend to pinch out farther downdip, and the overall productivity of the aquifer decreases. The Yegua-Jackson Aquifer can yield small to moderate quantities of groundwater to wells in GMA 12 (LBG-Guyton, 2003; George and others, 2011; Rogers, 1967).

5.3.1.5 Brazos River Alluvium Aquifer

The Brazos River Alluvium Aquifer occurs along the Brazos River between the Post Oak Savannah and Brazos Valley GCDs. The aquifer is present in the shallow floodplain deposits of the Brazos River that range from clay to gravels or large cobbles. The aquifer is typically less than 100 feet thick and only occurs under unconfined conditions and is hydraulically connected to the Brazos River. It is typically also in hydraulic connection with underlying aquifers where the alluvial sediments overlie the outcrops of those aquifers. The Brazos River Alluvium Aquifer only occurs within about five miles of the Brazos River, as shown in Figure 5-10.

5.3.2 Total Estimated Recoverable Storage (TERS)

Part of the evaluation of the hydrological conditions of the aquifers within a GMA is the TERS value provided by the TWDB. The TWDB defines “recoverable” as the estimated amount of groundwater that accounts for recovery scenarios that range from 25% to 75% of the total amount of groundwater in storage.

It is important to note that the TERS is solely based on how much water is present in the subsurface within the “official” aquifer extents defined by the TWDB according to the regional GAM or other method used to estimate the storage. If an aquifer had an active model cell within an area in the GAM, it was included in the TERS calculations regardless of whether or not it could actually produce water for water supply purposes. The process does not consider water quality, meaning that brackish or even saline groundwater present in an aquifer is included in the total. TERS is a "one-size-fits-all" definition of groundwater based solely on GAM parameters, when in reality the actual amount of recoverable groundwater will vary based on the aquifer type and other conditions.

A good example of this is the Carrizo-Wilcox Aquifer in Fayette County. According to the TWDB TERS report to GMA 12 (Wade and Shi, 2014), there is 95,000,000 acre-feet of water in storage in the Carrizo-Wilcox in Fayette County, as shown in Table 5-10.

Table 5-10. Total Estimated Recoverable Storage (TERS) in the Carrizo-Wilcox Aquifer in Fayette County

Hydrostratigraphic Unit	Total Storage (acre-feet)
Carrizo	20,000,000
Calvert Bluff	36,000,000
Simsboro	14,000,000
Hooper	25,000,000
Total	***95,000,000***

The TWDB TERS report states that there is 75,000,000 acre-feet of water in storage in the Wilcox portion of the Carrizo-Wilcox Aquifer in Fayette County. In reality, there are no wells in the Wilcox portion of the Carrizo-Wilcox Aquifer in Fayette County. All three Wilcox hydrologic units were declared "not relevant" by the GMA because these units are too deep and contain water that is too poor quality to be usable for water supply purposes.

For realistic planning purposes, the Carrizo is the only hydrostratigraphic unit within the Carrizo-Wilcox aquifer in Fayette County that is actually suitable for water supply purposes. Therefore, the stated TERS for the Carrizo-Wilcox Aquifer in Fayette County of 95,000,000 acre-feet is misleading. In reality, the true amount of groundwater storage available for water supply purposes is probably at most 20,000,000 acre-feet, with part of that amount being brackish groundwater, which is significantly less than the 95,000,000 acre-feet estimated in Wade and Shi (2014).

The TERS for GMA 12 were provided by the TWDB in GAM Task 13-035 (Wade and Shi, 2014). This report is provided in Appendix F. Table 5-11 summarizes the total amount of groundwater in storage according to the estimates made by the TWDB and provided in that report. It should be noted that although a new GAM was developed for the GMA 12 area for the Sparta, Queen

City, and Carrizo-Wilcox Aquifers, updated TERS values have not been provided by the TWDB at the time of this report.

Table 5-11. Total Amount of Groundwater in Storage (TERS) (in acre-feet) in GMA 12

County	Trinity	Carrizo-Wilcox	Queen City	Sparta	Yegua-Jackson	Gulf Coast	Brazos River Alluvium
Bastrop	9,000,000	98,000,000	9,500,000	2,500,000	290,000	--	--
Brazos	--	69,000,000	25,000,000	4,250,000	30,000,000	450,000	290,000
Burleson	--	120,000,000	29,000,000	4,000,000	27,000,000	--	450,000
Falls	--	820,000	--	--	--	--	140
Fayette	--	95,000,000	4,750,000	12,000,000	27,000,000	--	--
Freestone	--	46,000,000	290,000	--	--	--	--
Lee	500,000	130,000,000	23,000,000	10,000,000	10,000,000	--	--
Leon	--	180,000,000	25,000,000	4,600,000	76,000	--	--
Limestone	--	12,000,000	--	--	--	--	--
Madison	--	110,000,000	20,000,000	16,000,000	15,000,000	--	--
Milam	--	47,000,000	650,000	--	--	--	28,000
Navarro	--	1,000,000	--	--	--	--	--
Robertson	--	110,000,000	8,800,000	1,300,000	--	--	270,000
Williamson	1,600,000	500,000	--	--	--	--	--
TOTAL	***11,100,000***	***1,019,320,000***	***160,240,000***	***79,400,000***	***109,366,000***	***450,000***	***1,038,140***

5.3.3 Average Annual Recharge, Inflows, and Discharge

A required component for characterizing the hydrological conditions of aquifers within a GMA is estimating values for average annual recharge, inflows, and discharge for each aquifer. These values were provided by the TWDB to each GCD within GMA 12 as "GAM Run" reports in support of the development of district management plans. The following reports were provided for the GMA 12 area by the TWDB:

- Fayette County GCD - GAM Run 17-019 (Shi, 2018)
- Lost Pines GCD - GAM Run 16-014 (Wade, 2017)
- Post Oak Savannah GCD - GAM Run 16-015 (Ballew, 2017)

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- Brazos Valley GCD - GAM Run 18-021 (Wade, 2019)
- Mid-East Texas GCD - GAM Run 18-020 (Wade, 2019)

These TWDB reports are provided in Appendix G through Appendix K. The values of the annual average recharge, inflows, and discharge compiled from these reports were provided to GMA 12 in a presentation on January 29, 2020 entitled "GMA 12: Hydrological Conditions Consideration Discussion." This presentation is included as Appendix N.

Values for the Brazos River Alluvium Aquifer were not provided by the TWDB and are therefore not included in this report.

5.4 Environmental Factors

Texas Water Code §36.108 (d)(4) requires that, during the joint-planning process, districts shall consider "other environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water."

Groundwater pumping causes the hydraulic pressure in the pumped well and in the surrounding aquifer to decline. If the pumping is sufficiently large and sufficiently long, the decline in hydraulic pressure can spread into the shallow groundwater flow system near a spring or surface water body. If this occurs, the water level in the aquifer decreases and hydraulic gradient between the groundwater and the surface water body changes. If the water flowed from the aquifer to a spring or a surface water body prior to pumping, then groundwater pumping will lessen or reverse the hydraulic gradient. A decrease in the hydraulic gradient from the groundwater system to the surface water system can cause a reduction in spring flow or a reduction in stream baseflow. A complete reversal of the hydraulic gradient causes the flow direction to change, resulting in flow from the stream or surface water body into the aquifer. In the case of springs, if the pumping causes the water level to drop below land surface, and the regional flow system is the only source of water to the spring, then the spring will stop flowing.

The process by which pumping can impact the direction and magnitude of the flows between groundwater and surface water was discussed in a GMA 12 meeting on September 18, 2020. A presentation was prepared and presented by the hydrogeological consultants to member districts of GMA 12 and is titled "Presentation to GMA-12: Environmental Impact Considerations." This presentation is included as Appendix O. As explained in the presentation, the groundwater availability models used to set the GMA 12 DFCs are suitable for developing some qualitative relationships between pumping and groundwater-surface water exchange.

However, the GAMs are not suitable for developing quantitative relationship between pumping and groundwater-surface water exchange without refinement in their representation of changing surface water levels over time and subsequent validation using measured field data.

GMA 12 acknowledges that both spring flow and groundwater-surface water interactions are potentially important environmental issues. However, GMA 12 did not set a DFC for these flow components for several reasons. In the case of groundwater-surface water interaction, it is redundant to set a DFC because river authorities are already actively monitoring and managing flows in the major rivers as part of the Texas Instream Flow Program. The Texas Instream Flow Program was created by the Texas Legislature in 2001 to assess how much water rivers need to maintain a sound ecological environment. The program is administered by three agencies: Texas Commission on Environmental Quality, Texas Parks and Wildlife Department, and TWDB. The dam releases and active monitoring by the river authorities as part of this program will prevent groundwater pumping from ever reducing river flows enough to cause a risk to the health of the river aquatic system. This also provides an early warning system if groundwater pumping ever does become a problem, without the need for the GMA to set an additional DFC. Another reason for not developing a DFC for stream or spring flow is that the GAMs do not yet provide reliable predictions of how pumping will impact flows to either springs or rivers and streams. Therefore, the GMA has no defensible scientific basis by which to set establish DFC for spring flow. In addition, the concept of a spring flow DFC is more problematic than the limitations associated with the GAM predictions because there is insufficient historical data on spring flows from which to develop a meaningful spring flow DFC.

5.5 Subsidence

Texas Water Code Section 36.108 (d)(5) requires that, during the joint-planning process, GCDs shall consider "the impact on subsidence." This section details the potential impact of the DFCs on subsidence within GMA 12. The process by which pumping can cause subsidence was discussed in a GMA 12 meeting on July 24, 2020. A presentation was prepared and presented by the hydrogeological consultants to member districts of GMA 12 and is titled "Evaluation of the Potential Impact of Subsidence in GMA 12." This presentation is included as Appendix P.

The potential for significant measurable subsidence is generally related to the age of the sediments and the depth of sediment burial (Gabrysch, 1984). This is because fine grained sedimentary strata will naturally experience compaction over geologic time as more sediment is deposited above the layers and as the layers are more deeply buried. The aquifers that provide water in GMA 12 are composed of essentially unconsolidated layers of sand, clay, shale, and minor amounts of gravel. Sand and clay layers are interbedded throughout most of the aquifers within the GMA, with some layers consisting of mostly clay with minor amounts of sand (e.g. the Hooper Formation) and others with thick sand layers and minor amounts of clay (e.g., the Simsboro Formation). In these types of aquifers, land subsidence can occur when pumping from wells results in large decreases in artesian hydraulic head that in turn cause depressurization of the clay layers and a subsequent release of water and vertical compaction of the clays. The vertical compaction of the clay layers, if sufficiently large, will be associated with an equivalent lowering of land surface elevation.

Land surface subsidence within the state of Texas has been identified and measured in the Houston-Galveston area (Gabrysch, 1984; Holdahl et al., 1898) as well as in parts of far West Texas (Chi and Reilinger, 1984). Although the Gulf Coast formations in the Houston-Galveston area are lithologically similar to those in GMA 12, they are much younger (typically less than 5 million years old), meaning that the clay strata have not experienced much natural consolidation. Therefore, the Gulf Coast sediments are more susceptible to significant pumping-related dewatering and vertical compaction than the sediments in the GMA 12 area.

The aquifers that provide water in GMA 12 are substantially older (33 to 55 million years old) than the Gulf Coast formations in the Houston-Galveston area (Dutton et al., 2003). The clay and shale strata within the aquifers of GMA 12 have already experienced considerable natural compaction and are therefore considered to have a low risk of pumping-related consolidation. In addition, subsidence has not been identified anywhere within GMA 12, despite large-scale pumping and associated drawdowns in several major pumping centers including Bastrop and the Bryan-College Station area (Huang et al., 2012). Based on the age of the aquifers in GMA 12 and the lack of previously observed subsidence despite significant pumping, the overall risk of subsidence within GMA 12 is assumed to be slight.

The subsidence risk report recently produced for the TWDB (Furnans et al, 2017) uses a scoring system for a list of risk factors to assign a total weighted risk for subsidence to the major and minor aquifers of Texas. This report assigns a high subsidence risk to the Yegua-Jackson and Carrizo-Wilcox aquifers and a medium subsidence risk to the Queen City and Sparta aquifers. These total risk values are based on a set of factors (clay thickness and extent, overall lithology, current water levels, predicted water level trends) that attempt to provide an a priori estimate of the potential for subsidence, but do not account for any current observed subsidence within the specific aquifers. As previously stated, there have been no reports of observable subsidence anywhere within the districts of GMA12, even in areas with significant pumping-related drawdowns. Based on the age and nature of the formations within GMA12 and the lack of previously observed subsidence, the overall risk of subsidence within GMA 12 is assumed to be negligible. Therefore, the proposed DFCs are not expected to have any negative impact on subsidence within GMA 12.

5.6 Socioeconomics

Texas Water Code Section 36.108 (d)(6) requires that, during the joint-planning process, GCDs shall consider "socioeconomic impacts reasonably expected to occur." The following is a discussion of GMA 12's consideration of the sixth factor listed in Subsection 36.108 (d) of the Texas Water Code to be discussed in the Explanatory Report (ER), and a review of how the relevant aquifer DFCs within GMA 12, impact this factor. The GMA considered socioeconomic impacts reasonably expected to occur as a result of the proposed DFCs for relevant aquifers. The consideration of socioeconomic impacts as part of state water planning, both at the regional and state level, has been an element of the planning process dating back to the 1990s.

5.6.1 Regional Planning Assessment of Socioeconomic Impact

During each five-year planning cycle, regional water planning groups (RWPGs) evaluate population projections, water demand projections, and existing water supplies. Each planning group then identifies water shortages under drought of record conditions, a critical component to both the regional water plans (RWPs) and the State Water Plan. Determining and evaluating both short- and long-term water supply needs help us to better understand "how the needs for water could affect communities throughout the State during average precipitation periods and during a severe drought and to plan for meeting those needs" (TWDB, 2012). In addition, water management strategies are developed and recommended by the planning groups to address the potential shortages identified. The goal of the water planning process is to ensure that entities have adequate water supplies in times of drought. In order to reach this goal, the TWDB, which is statutorily responsible for administering the regional water planning process, provides guidance within the Texas Administrative Water Code.

The analysis performed by the TWDB consists of a series of point estimates of one-year droughts at 10 year intervals. The socioeconomic impact analysis attempts to measure the impacts on water user groups should the identified water supply needs not be met. For this socioeconomic impact analysis, multiple impacts are examined including:

- Sales income and tax revenue
- Jobs
- Population
- School enrollment

The regional water planning process and the development of the State Water Plan are governed differently statutorily than the GMA's joint planning process. The processes for both the regional water plans and the State Water Plan are directed by 31 Texas Administrative Code Chapter 357, which requires planning groups to use the results of the socioeconomic impact analysis provided by the TWDB and the data developed within the joint planning process by the GMAs. In contrast, the joint planning process is governed by the Texas Water Code Chapter 36, which has a different directive provided to GMAs and GCDs in Subsection 36.108(d). This directive requires GCDs to consider the socioeconomic impacts reasonably expected to occur prior to adopting a proposed DFC, and then for an adopted DFC, the Explanatory Report developed in support of the joint planning process, should document that the nine factors were considered.

5.6.2 Other Considerations of Socioeconomic Impacts

The method used by the TWDB for evaluating social and economic impacts for not meeting shortages considers the demand side. This analysis concentrates on impacts or benefits of providing water to people, business and the environment. To develop economic baselines, the most widely used tools are input/output models (IO models) combined with social accounting matrices (SAMs). These are referred to as IO/SAM models. These tools formed the basis for estimating agriculture (irrigation and livestock water uses), and industry (manufacturing, mining, steam-electric, and commercial business activity for municipal water uses).

The socioeconomic impact analyses provided by the TWDB to Regions C, G, H and K regional planning groups for the 2021 Regional Water Plans (Ellis 2019 and 2020 were considered as part of the GMA 12 deliberations on socioeconomic impacts reasonably expected to occur as a result of the proposed DFCs for relevant aquifers in GMA 12. Those documents illustrate the regional impacts of not meeting water supply needs within a region for specific water user groups. Figures 5-12 and 5-13 illustrate the socioeconomic impacts of not meeting water supply needs in Region G based on the 2021 Region G Regional Water Plan. As shown on Figure 5-12, lost income within the region could reach about $12 billion by 2060 on an annual basis. Similarly,

Figure 5-13 illustrates that there could be a loss in population of about 20,000 people by 2060 if the projected water demands are not met. For full analysis, see Norvell and Shaw (2010).

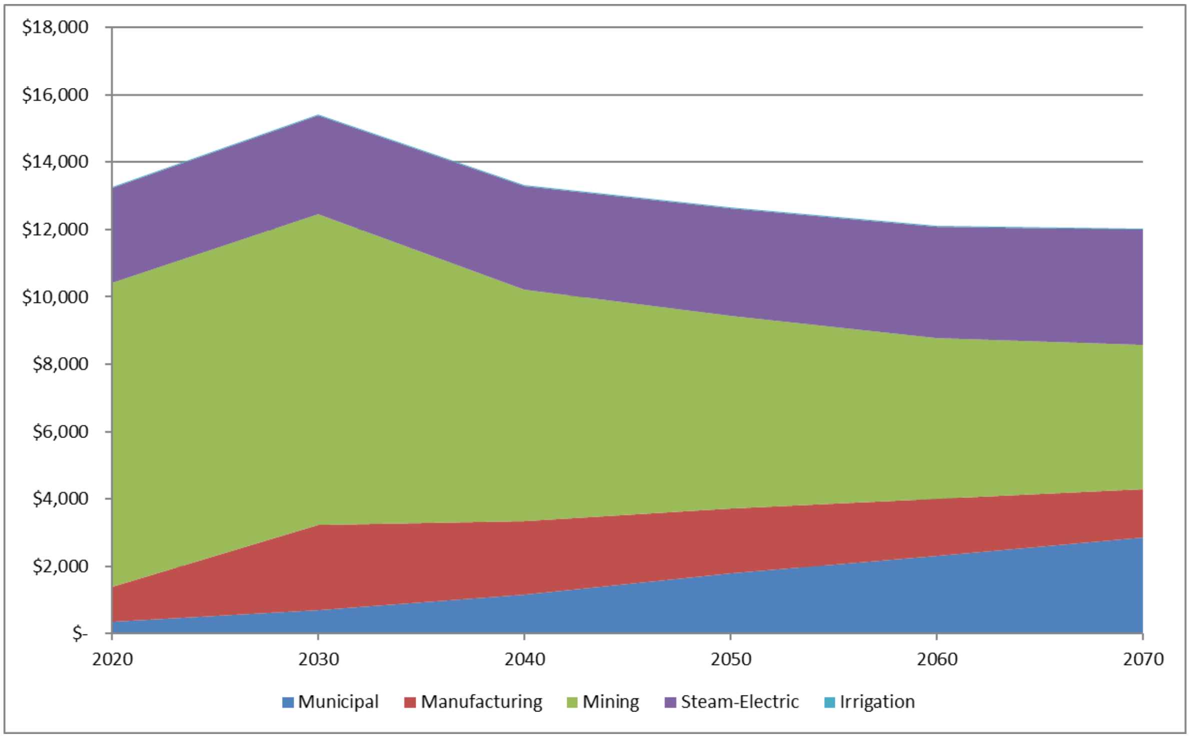

Figure 5-12. Socioeconomic Impacts Analysis – 2011 Brazos G Regional Water Plan Lost Income by Sector (millions of $)

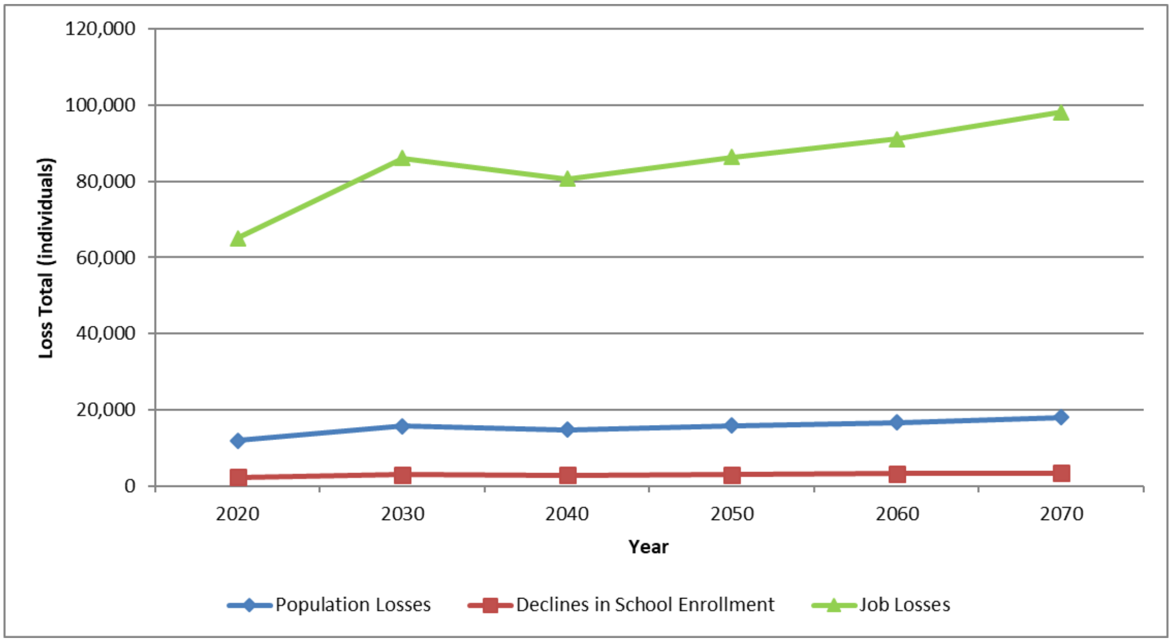

Figure 5-13. Social Impacts of Water Shortages in Region G

5.6.3 Socioeconomic Considerations in GMA-12

The requirement that districts shall consider the socioeconomic impacts before voting on the desired futures conditions of the aquifers was added to the statues of joint planning with the passage of Senate Bill 660 in 2011. As part of their continued efforts to meet the "balance test" described in Subsection 36.108 (d-2) of the Texas Water Code, GMA 12 has considered socioeconomic impacts for this (second) third round of joint planning.

The potential socioeconomic impacts reasonably expected to occur due to DFCs were discussed in a GMA 12 meeting on October 22, 2020. A presentation was prepared and presented by the hydrogeological consultants to member districts of GMA 12 and is titled "GMA 12 Socioeconomic Impacts Considerations." This presentation is included as Appendix Q. GMA 12 held numerous meetings during the (second) third cycle of joint planning that provided opportunities for unrestricted public comment regarding socioeconomic impacts or the potential for them to occur. In this manner, district representatives were able to obtain stakeholder input from across GMA 12's geographical boundaries from a variety of interest areas such as recreation, real estate, commerce, irrigation and agriculture, political subdivisions, environmental groups, private property, tourism, cities, groundwater developers, river authorities and others. From a qualitative perspective, GMA 12 realizes that both positive and negative socioeconomic impacts may potentially result from the implementation of the proposed DFCs. In their deliberations while creating DFCs, district representatives aimed to achieve a balance of the positive and negative impacts.

GMA 12 examined the following socioeconomic considerations that would potentially have a positive impact upon the adoption of the proposed DFCs:

- Proposed DFCs in some areas of the GMA may reduce or eliminate the costs of lowering pumps or constructing new wells.
- Proposed DFCs may serve to sustain or enhance economic growth due to assurances provided by diversified water portfolios.
- Proposed DFCs may result in a short-term reduction in utility rates due to reduction in cost of regional water management strategy implementation.
- Proposed DFCs should help ensure part or all of a long-term supply for an area.

Comparatively, the following socioeconomic considerations were identified as potentially having a negative impact upon the adoption of the proposed DFCs:

- Proposed DFCs may require conversion of part or all of a supply to an alternative supply or supplies, which may have increased costs associated with infrastructure, operation and maintenance.
- Proposed DFCs in some areas of the GMA may result in significant but unquantified production cost increases due to continuing to lower water levels in wells or lowered pumping rates from wells.
- Alternatives to proposed DFCs may result in a reduced groundwater supply being available on a long-term basis.
- Proposed DFCs may require the lowering of well pumps and/or constructing deeper new wells.

5.6.4 Impacts of Major and Minor Aquifer DFCs on Socioeconomic Impacts Reasonably Expected to Occur

There are many challenges involved with directly assessing socioeconomic impacts likely to occur for the major and minor aquifer DFCs within GMA 12. Numerous factors can feasibly contribute to potential economic or social impacts of water planning on the water user.

Regional DFCs are one factor to be considered, and are not a guarantee for social or economic stability, development opportunities or prosperity to any user.

Although DFCs are an important variable in establishing a framework for setting long-term water management plans and practices, they are not the only variable to be studied. Other factors to be considered are the occurrence of drought and demographic shifts. Both of these factors play a role in impacting the outcome of how water is managed economically and socially.

By setting DFCs for the Carrizo-Wilcox, Queen City, Sparta, Yegua-Jackson, and Brazos River Alluvium aquifers that meet current demands and achieve a balance in providing water availability for growth and preservation, GMA 12 believes these DFCs meet the "balance test" prescribed by Subsection 36.108 (d 2) of the Texas Water Code.

5.7 Private Property Rights

Texas Water Code Section 36.108 (d)(7) requires that, during the joint-planning process, GCDs shall consider "the impact on the interests and rights in private property, including ownership and the rights of management area landowners and their lessees and assigns in groundwater as recognized under Section 36.002." GMA 12 recognizes that the primary method by which private property rights are protected in GMA 12 is through each GCD's management plan and groundwater rules. Because the local hydrogeological conditions, environmental, and socioeconomic factors vary across GMA 12, the manner in which GCDs protect private property rights may vary among the GCDs.

GMA 12 members considered private property rights during the DFC development process in several ways. GMA 12 members reviewed the component GCDs' management plans to insure they appropriately address private property rights. Groundwater Management Area 12 also had a presentation on the private property rights impact from DFCs on September 18, 2020 (Appendix R). This presentation included discussion on recent court cases involving groundwater and private property rights as well as the potential consequences that imposing too lax or too restrictive DFCs can have on personal property rights. A keystone to all discussions regarding private property rights was the Texas Water Code Section 36.002, which reads as follows:

> "Sec. 36.002. OWNERSHIP OF GROUNDWATER.
>
> (a) The legislature recognizes that a landowner owns the groundwater below the surface of the landowner's land as real property.

(b) The groundwater ownership and rights described by this section entitle the landowner, including a landowner's lessees, heirs, or assigns, to:

(1) drill for and produce the groundwater below the surface of real property, subject to Subsection (d), without causing waste or malicious drainage of other property or negligently causing subsidence; and

(2) have any other right recognized under common law.

(b-1) The groundwater ownership and rights described by this section do not:

(1) entitle a landowner, including a landowner's lessees, heirs, or assigns, to the right to capture a specific amount of groundwater below the surface of that landowner's land; or

(2) affect the existence of common law defenses or other defenses to liability under the rule of capture.

(c) Nothing in this code shall be construed as granting the authority to deprive or divest a landowner, including a landowner's lessees, heirs, or assigns, of the groundwater ownership and rights described by this section.

(d) This section does not:

(1) prohibit a district from limiting or prohibiting the drilling of a well by a landowner for failure or inability to comply with minimum well spacing or tract size requirements adopted by the district;

(2) affect the ability of a district to regulate groundwater production as authorized under Section 36.113, 36.116, or 36.122 or otherwise under this chapter or a special law governing a district; or

(3) require that a rule adopted by a district allocate to each landowner a proportionate share of available groundwater for production from the aquifer based on the number of acres owned by the landowner.

(e) This section does not affect the ability to regulate groundwater in any manner authorized under:

(1) Chapter 626, Acts of the 73rd Legislature, Regular Session, 1993, for the Edwards Aquifer Authority;

(2) Chapter 8801, Special District Local Laws Code, for the Harris-Galveston Subsidence District; and

(3) Chapter 8834, Special District Local Laws Code, for the Fort Bend Subsidence District.

Based on a review of the GCDs' individual management plans and related factors, GMA 12 members do not anticipate that the adoption of the GMA 12 DFCs will significantly affect personal property rights associated with groundwater during the planning horizon. In crafting DFCs, GMA 12 aimed to balance property interests and rights that are benefitted by the use of groundwater in the present, near future and long term and those benefitted by preservation, or leaving groundwater in place. The DFCs adopted by GMA 12 are consistent with protecting property rights of landowners who are currently pumping groundwater and landowners who have chosen to conserve groundwater by not pumping. All current and projected uses, as defined in the Regions C, G, H, and K plans, were considered in developing the adopted desired future conditions. By setting DFCs for the GMA 12 that meet current demands and achieve a balance in providing water availability for growth and preservation, GMA 12 believes the adopted DFCs meet the "balance test" prescribed by Subsection 36.108 (d-2), Texas Water Code.

5.8 Feasibility of Achieving the Proposed Desired Future Conditions

Texas Water Code Section 36.108 (d)(8) requires that GCDs, during the joint groundwater planning process, to consider the feasibility of achieving the proposed DFC(s). This requirement was added to the joint groundwater planning process with the passage of Senate Bill 660 by the 82nd Texas Legislature in 2011. This consideration can be traced back to 2007, when the TWDB adopted rules that provided guidance for petitions contesting the reasonableness of an adopted DFC. Under these 2007 rules, the TWDB required that an adopted DFC must be physically possible from a hydrological perspective.

From 2010 to 2011, the TWDB reviewed multiple petitions regarding the reasonableness of adopted DFCs in GMAs. Their evaluation of whether or not an adopted DFC was physically possible was based on whether or not the DFC(s) could be reasonably simulated using the TWDB's adopted GAM for the aquifer(s) in question. This approach presumes that, if a GAM simulation, which is based the physical laws of hydrology as incorporated in the mathematical model, can generate the DFC condition by implementing a future pumping scenario then the DFCs can be deemed to be physically possible and compatible

While GMA 12 recognizes that the GAMs represent the best science for understanding the groundwater flow systems in GAM 12, they also recognize that the GAMs have been demonstrated to contain error and uncertainty. As such, GMA 12's philosophy for both the previous and the current joint planning periods was that DFCs are feasible if they can be generated by a GAM within a reasonable tolerance. The factors used to determine what "a reasonable tolerance" means for GMA 12 include:

- GMA predictive uncertainty/error
- Errors in starting 2000 or 2010 water level conditions
- Errors in the aquifer hydraulic properties
- Uncertainty in future environmental conditions (for example, recharge and rivers levels)
- Uncertainty in future pumping rates and locations
- Non-uniqueness of model calibration

5.9 Any Other Relevant Information

Texas Water Code Section 36.108 (d)(9) requires that, during the joint-planning process, GCDs shall consider "any other information relevant to the specific desired future conditions." A significant amount of additional relevant information was presented during the 21 joint groundwater planning meetings held by GMA 12 from 2018 to 2021. Table 1-3 summarizes the presentations given to GMA 12 and all presentations and other material are available on the GMA 12 website (https://posgcd.org/agendas-minutes/gma-12-agendas-minutes/).

6. Other Desired Future Conditions Considered

Texas Water Code Section 36.108(d-3)(4) requires that, during the joint groundwater planning process, GCDs shall "list other desired future condition options considered, if any, and the reasons why those options were not adopted." Several different pumping scenarios and corresponding DFCs were considered by GMA 12 during the third round of joint groundwater planning, which primarily focused on two different aquifers- the Carrizo and the Simsboro Aquifer. This section provides a description of other DFCs that were considered by GMA 12.

6.1 Proposed Desired Future Conditions

The initial set of proposed DFCs adopted by GMA 12 are documented in a memorandum in Appendix S. The memorandum is dated April 22, 2021 and the DFCs adopted on that date are shown in Tables 6-1, 6-2, and 6-3.

Table 6-1. Proposed DFCs for GMA 12 for the Sparta, Queen City, Carrizo, Calvert Bluff, Simsboro, and Hooper Aquifers [1,2]

GCD	Average Aquifer Drawdown (feet) from January 2011 through December 2070					
	Sparta	Queen City	Carrizo	Calvert Bluff	Simsboro	Hooper
Brazos Valley GCD	50	43	84	116	261	178
Fayette County GCD	40	65	122	Declared as non-relevant		
Lost Pines GCD	22	28	137	154	311	173
Mid-East Texas GCD	25	21	49	59	81	73
Post Oak Savannah GCD	32	31	172	179	336	214

[1] The proposed DFCs are based on Run 12 for the Updated Groundwater Availability Model for the central portion of the Sparta, Queen City, and Carrizo-Wilcox Aquifers (INTERA and others, 2020). Fayette County GCD did not propose a DFC for the Calvert Bluff, SImsboro, or the Hooper Aquifers because the district declared these three aquifers as non-relevant aquifers.

[2] Districts may adopt Proposed DFCs within a range of 10% above or below the values in the aquifers listed in Table 6-1 (modified from Table 1 in Appendix S)

Table 6-2. Proposed DFCs for GMA 12 for the Yegua-Jackson Aquifer [1]

GCD	Average Drawdown (feet) from January 2010 to December, 2069
Brazos Valley	61
Post Oak Savannah	100
Mid-East Texas	7
Fayette County	77

[1]The proposed DFCs are based on Run YGJK-PS2 for the Groundwater Water Availability Model for the Yegua-Jackson Aquifer (INTERA and others, 2020). Lost Pines GCD did not propose a DFC for the Yegua-Jackson Aquifer because the district declared the Yegua-Jackson Aquifer as a non-relevant aquifer.

Table 6-3. Proposed DFCs for GMA 12 for the Brazos River Alluvium [1]

County	Desired Future Condition Statement
Milam County	A decrease of 5 feet in the average saturated thickness over the period from January 1, 2010 to December 31, 2069. The baseline average saturated thickness for 2010 is estimated at 24.5 feet and is based on an analysis of historical water level data and well depth values
Burleson County	A decrease of 6 feet in the average saturated thickness over the period from January 1, 2010 to December 31, 2069. The baseline average saturated thickness for 2010 is estimated at 38.5 feet and is based on an analysis of historical water level data and well depth values.
Brazos and Robertson Counties	Percent saturation above well depth shall average at least 30 percent for wells located north of State Highway 21 and 40 percent for wells located south of State Highway 21. If the percent saturation criteria are reached for three consecutive years then the DFC would be reached.

[1] The proposed DFCs remain the same as the current DFCs. The DFCs were checked with Run 2 for the Brazos River Alluvium GAM (Ewing and Jigmond, 2016)

The proposed DFCs for the six aquifers in Table 6-1 are based on GAM Run S-12. On March 18, 2021 GMA 12 voted to develop a resolution and to formally adopt the proposed DFCs. The 2070 production rates for each of the six aquifers in GAM Run S-12 either reached or exceeded the permitted aquifer pumping except for the portion of the Simsboro and the Carrizo aquifers in POSGCD. GAM Run S-12 evolved from GAM Run S-7 based on suggestions made by POSGCD and BVGCD. The suggestions led to the development of GAM Runs S-10, S-11, and S-13. The suggestions were all accepted by GMA 12 except for a POSGCD request to reduce the maximum production from the Carrizo Aquifer in POSGCD from 18,207 ac-ft/yr to 12,000 ac-ft/yr in the final simulation to determine proposed DFCs.

POSGCD's request to reduce the Carrizo Aquifer in POSGCD from 18,207 ac-ft/yr to 12,000 ac-ft/yr was based on analysis and model simulations performed by POSGCD. Selected results of POSGCD analysis were presented and discussed in several GMA 12 meetings GMA 12's primary rational for not accepting POSGCD request to lower the DFC for the Carrizo Aquifer was centered on the concept of "known pumping." "Known pumping" was a term used by some of the GCDs in GMA 12 to refer to permitted pumping that had occurred or would occur in the near future. "Known pumping" was a type of permitted pumping that a majority of GCDs in GMA 12 believes should be included in the pumping file for a DFC Run. POSGCD was requesting to reduce the production associated with a Vista Ridge project to less than the project was planning to pump from the Carrizo in 2022. Because this Vista Ridge Carrizo pumping was already planned to occur the GCDs besides POSGCD considered the Vista Ridge permitted pumping from the Carrizo as "known pumping."

In response to GMA 12 not seconding their motions to lower the DFC for the Carrizo aquifer in POSGCD, POSGCD prepared a position paper that was sent to four other GCDs in GMA 12. Appendix T contains the POSGCD paper. Out of the four GCDs that received a copy of POSGCD position paper, only BVGCD provided a written response. Appendix U contains a copy of BVGCD written response.

The proposed DFC for Yegua-Jackson Aquifer in Table 6-2 were discussed and tentatively agreed on during GMA 12 meetings on January 29, 2020. On March 18, 2021 GMA 12 voted to develop a resolution to formally adopt the proposed DFCs. No alternative DFCs were considered or proposed by a GCD prior to April 22, 2021.

The proposed DFC for Brazos River Alluvium Aquifer in Table 6-3 were discussed and tentatively agreed on November 15, 2019 and February 12, 2021. On March 18, 2021 GMA 12 voted to develop a resolution to adopt the proposed DFCs. No alternative DFCs were proposed by a GCD prior to April 22, 2021.

6.2 Adopted Desired Future Conditions

The proposed DFCs for the six aquifers in Table 6-1 were not adopted by GMA 12. During the comment period for the proposed DFCs, it was determined that the pumping file constructed in 2018 or 2019 did not include pumping for two groundwater development projects located in the southeast part of Caldwell and the east part of Gonzales counties. These projects began the construction and equipping of wells approximately eighteen months ago, and are permitted to produce a combined 31,320 ac-ft/yr from the Carrizo Aquifer. To account for pumping from these two projects on drawdown in GMA 12, GAM Run S-19 was created. The DFCs adopted by GMA 12 for the six aquifers listed in Table 6-1 were modified to account for the drawdown impacts caused by the two projects in GMA 13.

After receiving comments on the proposed DFCs, the Board of Directors for Lost Pines GCD voted to not support the proposed DFC for the Simsboro Aquifer in Table 6-1. Subsequently, Lost Pines GCD evaluated several modifications of GAM Run S-12 where the total pumpage in the Simsboro Aquifer was reduced, resulting in lower drawdowns. A drawdown of 182 feet in Lost Pines GCD in the Simsboro Aquifer resulted from a total pumping similar to the current modeled available groundwater totals for the district of between 30,000 and 35,000 ac-ft/yr, and these DFCs, shown in Table 6-4, were presented to GMA 12 for consideration on November 30, 2021. GMA 12 did not accept the DFCs shown in Table 6-4, but did agree to an average drawdown for LPGCD for the Simsboro Aquifer of 240 feet by 2070. This is the same as the DFC adopted by LPGCD and GMA 12 in the last round of GMA 12 planning in 2017. The DFC of 240 feet was chosen as the preferred option because GMA 12 decided that consistency was important for such a pivotal resource.

Table 6-4. Drawdowns from 2011 to 2070 Considered for Reduced Simsboro Pumpage in Lost Pines GCD in GAM Run S-20

GCD	Average Aquifer Drawdown (ft) measured from January 2011 through December 2070					
	Sparta	Queen City	Carrizo	Calvert Bluff	Simsboro	Hooper
Brazos Valley GCD	47	39	70	86	188	131
Fayette County GCD	42	70	134	Declared as non-relevant		
Lost Pines GCD	22	27	125	110	182	106
Mid-East Texas GCD	25	20	47	56	74	68
Post Oak Savannah GCD	32	30	158	147	258	163

The proposed DFCs for the Yegua Jackson Aquifer in Table 6-2 were slightly modified by GMA 12 before they were adopted. The adopted DFCs were based on the same GAM Run as were the proposed DFCs, but were adjusted to include a 10% increase in the DFC value for BVGCD. The 10% increase was the maximum amount allowed by a 10% variance allowed by GMA 12 from the predictions from a GAM DFC simulation.

The proposed DFC for the Brazos River Alluvium Aquifer in Table 6-3 were adopted by GMA 12. No other DFCs were considered by GMA 12 for the BRAA other than the proposed DFCs.

7. Recommendations and Comments Received

This section provides a summary of the comments received by GMA 12 and GMA 12 member GCDs on the proposed DFCs and during the minimum 90-day period for public comment on the DFCs proposed by GMA 12. Comments received by GMA 12 or GMA 12-member GCDs on the proposed DFCs during the 90-day comment period, and the full text of the comments and

GMA 12's response to the comments are provided in Appendices S through W. Only specific comments on the proposed DFCs are addressed in this report.

7.1 Comments Received by Brazos Valley GCD

Comments received by the Brazos Valley GCD and responses to these comments are provided in Appendix S. Only written comments made directly to the Brazos Valley GCD on proposed DFCs with application to at least the Brazos Valley GCD are included.

7.2 Comments Received by Fayette County GCD

Comments received by the Fayette County GCD and responses to these comments are provided in Appendix T. Only comments made directly to the Fayette County GCD on proposed DFCs for Fayette County are included.

7.3 Comments Received by Lost Pines GCD

Comments received by the Lost Pines GCD and responses to these comments are provided in Appendix U. Comments made directly to the Lost Pines GCD on proposed DFCs for Bastrop and Lee Counties, as well as comments made to GMA 12 by Lost Pines GCD stakeholders, are included.

7.4 Comments Received by Mid-East Texas GCD

No comments were received by the Mid-East Texas GCD on the proposed DFCs.

7.5 Comments Received by Post Oak Savannah GCD

Comments received by the Post Oak Savannah GCD and responses to these comments are provided in Appendix V. Only comments made directly to the Post Oak Savannah GCD on proposed DFCs for Burleson and Milam Counties are included.

7.6 Comments Received from Texas Water Development Board

No comments were received from the Texas Water Development Board.

8. Summary

The adopted DFCs were approved by GMA 12 on November 30, 2021. This report provides a review of the GMA 12 area, the technical and policy justifications for the adopted DFCs, and the nine factors that were considered during the development of the DFCs, as required by Section 36.108(d)(1-8) of the Texas Water Code. This report also includes comments and alternative DFCs that were proposed by stakeholders in the GMA, and GMA 12's responses to these comments.

8.1 Summary of DFCs

The final DFCs adopted by GMA 12 are summarized in Tables 8-1 through 8-3.

Table 8-1. Final Adopted DFCs for the Sparta, Queen City, Carrizo, Calvert Bluff, Simsboro, and Hooper Aquifers

GCD or County	Average Aquifer Drawdown (feet) measured from January 2000 through December 2069					
	Sparta	Queen City	Carrizo	Calvert Bluff	Simsboro	Hooper
Brazos Valley GCD*	53	44	84	111	262	167
Fayette County GCD**	43	73	140	Declared as non-relevant		
Lost Pines GCD	22	28	134	132	240	138
Mid-East Texas GCD	25	20	48	57	76	69
Post Oak Savannah GCD	32	30	146	156	278	178
Falls County	--	--	--	--	7	3
Limestone County	--	--	--	2	3	3
Navarro County	--	--	--	0	1	0
Williamson County	--	--	--	25	31	24
GMA 12	***33***	***32***	***96***	***98***	***169***	***110***

*Brazos Valley GCD DFCs are for2000 through December 2070

**Fayette County GCD DFCs are for all of Fayette County

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Table 8-2. Final Adopted DFCs for the Yegua-Jackson Aquifer

GCD or County	Average Aquifer Drawdown (feet) measured from January 2010 through December 2069
Brazos Valley GCD	67
Fayette County GCD	81
Lost Pines GCD	--
Mid-East Texas GCD	8
Post Oak Savannah GCD	61
GMA 12	***55***

Table 8-3. Final Adopted DFCs for the Brazos River Alluvium Aquifer.

GCD	County	Brazos River Alluvium Aquifer
Brazos Valley	Brazos and Robertson	North of State Highway 21: Percent saturation shall average at least 30% of total well depth from January 2013 to December 2069. South of State Highway 21: Percent saturation shall average at least 40% of total well depth from January 2013 to December 2069.
Post Oak Savannah	Burleson	A decrease in 6 feet in the average saturated thickness over the period from January 2010 to December 2069.
	Milam	A decrease of 5 feet in average saturated thickness over the period from January 2010 to December 2069

8.2 Rationale and Justification for DFC Selection

The newly adopted DFCs are different from current DFCs in several of the aquifers, specifically the Sparta, Queen City, and Carrizo-Wilcox (including the Carrizo, Calvert Bluff, Simsboro, and Hooper) aquifers. The use of the updated Queen City/Sparta/Carrizo-Wilcox GAM significantly changed the drawdowns calculated by the model, which required changes to the DFCs in order for them to be deemed feasible. The DFCs for the Yegua-Jackson and Brazos River Alluvium aquifers are very similar to the previous DFCs adopted by GMA 12.

Section 5 of this Explanatory Report provides a discussion of the nine factors that were considered during the development of the initially proposed DFCs. In addition to these nine factors, GMA 12 received a significant amount of additional relevant information in meetings held from 2018 to 2021. GMA 12 also considered other factors, including stakeholder

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comments and an assessment of achieving a balance between groundwater production and preservation.

GMA 12's decision to adopt DFCs was based on a variety of factors, including the nine required factors as well as additional information provided to the GMA at joint planning meetings held from 2018 to 2021 and input from stakeholders during the public comment period after the initial DFCs were proposed. GMA 12 attempted to adopt DFCs that provided a reasonable balance between groundwater production and conservation, preservation, and protection of groundwater.

GMA 12 reconsidered and adjusted the DFC for the Simsboro Aquifer in the Lost Pines GCD. Originally proposed to be 311 feet of drawdown from 2010 to 2070, GMA 12 ultimately adopted a DFC of 240 feet of drawdown. This DFC was the same as the previous DFC of 240 feet that was adopted during the second round of joint groundwater planning in 2016.

In GMA 12's resolution to adopt the final DFCs, POSGCD voted in favor for the DFCs with the caveat that it objected to the process. The rationale for POSGCD voting is that although they agreed with the DFCs the district did not support the process used to develop the DFCs. POSGCD objections are described in their position paper, which is presented as Appendix S.

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